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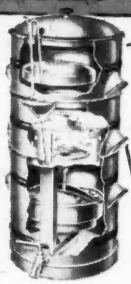

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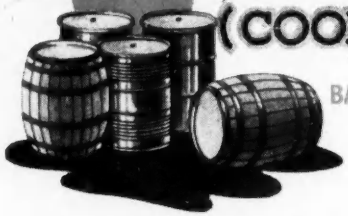

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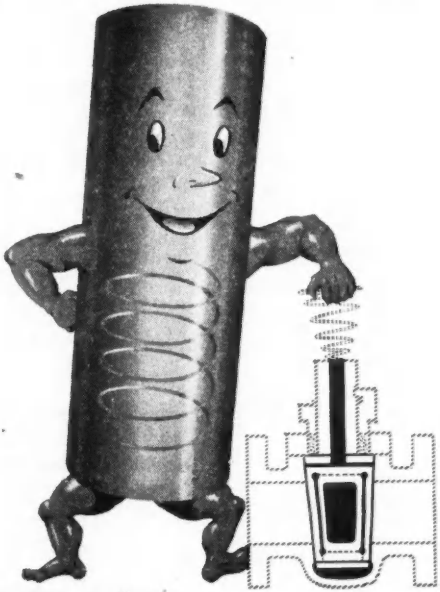

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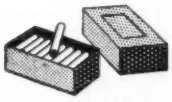

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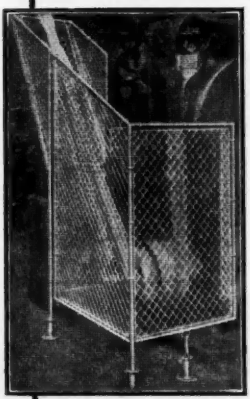

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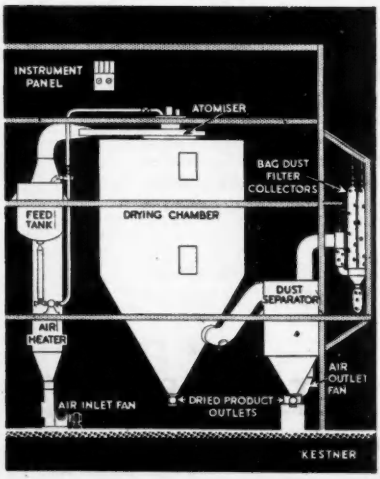

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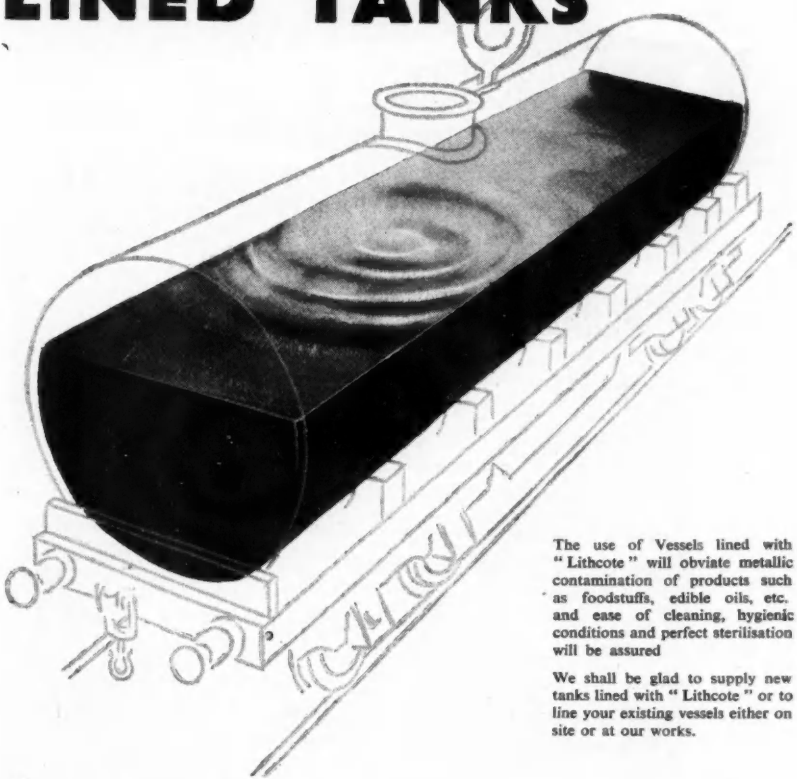

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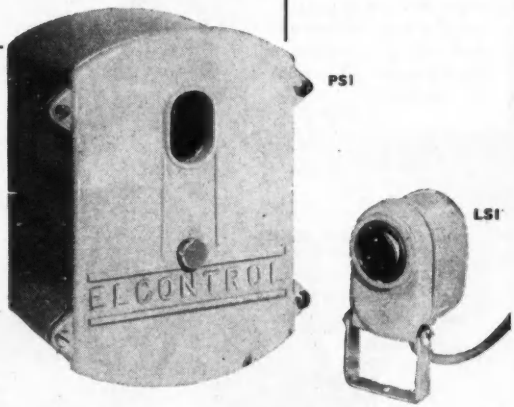

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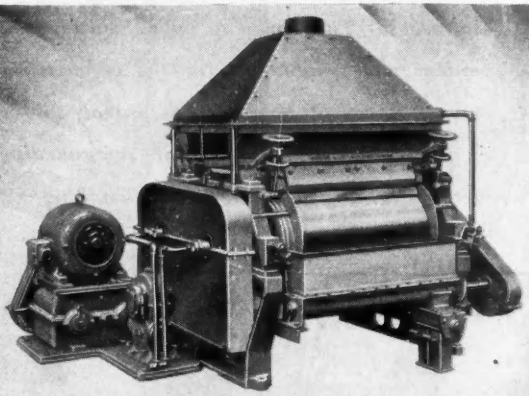

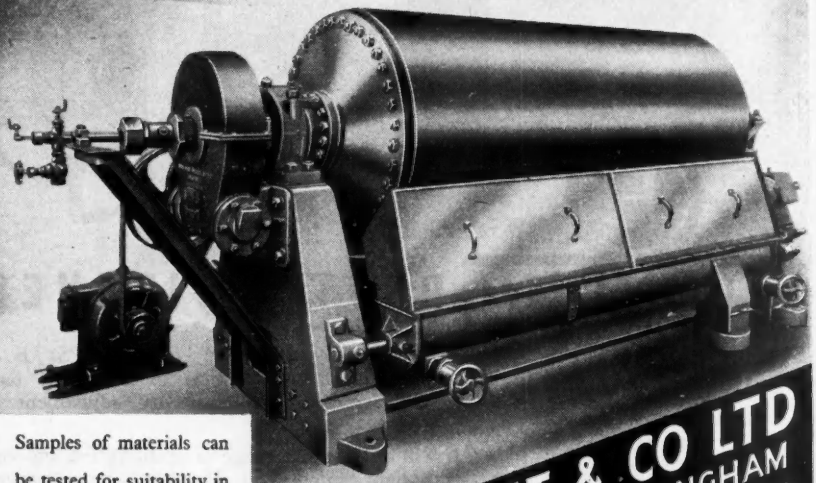

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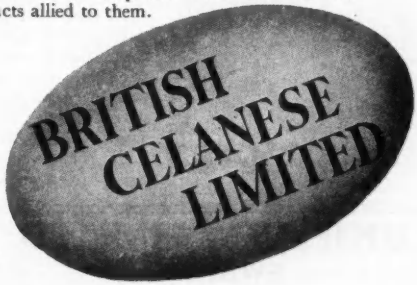

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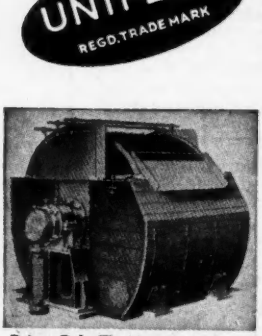

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Volume LXV 18 August 1951 Number 1675

Research from the West

EVEN in these days when hardly a production line is without the blessing of chemists cider may seem a long way removed from chemistry. The fermentation of specially grown apples is a particularly natural and traditional operation of the countryside. But the publication of the 1950 Annual Report from Long Ashton Research Station is a reminder that in 1903 West Country farmers and County Councils together bought a farm cottage and shed and eight acres of adjoining land and thus set up the National Fruit and Cider Institute at Long Ashton. In 1912 this private and independent research and educational centre became associated with the University of Bristol, under the Government scheme of that time for Agricultural Research Institutes, and it is now famous throughout the world as a research station with interests much wider ranged than the study of apple juice and its alcoholic conversion.

Chemists may have made important contributions to the practice of cider making but cider makers made a far greater contribution to chemical research when they founded this centre in the West. Names persist obstinately in the West and those who know the Long Ashton outskirts of Bristol may reflect upon the fact that the main gate of the research station is a bus-stop and fare-stage; and as such it is still known as 'The Cider Institute' though in Australia, Canada, and America this original name would mean nothing, whereas 'Long Ashton Research Station' would mean a great deal.

The station's Report for 1950, like every report that has come from Long Ashton for the past 20 years, presents a remarkably varied 'menu' of agricultural research. Not many pages would be intelligible to the original cider-making founders, but for chemists there is abundance indeed. There is a study of the hormone in developing apple seeds, and if this hormone is not yet identified it is at least shown that it is not indolyl acetic acid or any other known member of the cell-elongating auxin class. The long-term investigation of manurial treatments for blackcurrants is continued from previous years and it is shown that nitrogen is the most dominant yield-influencing nutrient and that the supply of this element is equivalently available from the inorganic 'Nitro-Chalk' and the organic meat and bone meal. From farmyard manures and composts nitrogen is much less effective even when equivalent quantities are given.

Studies have been made of zinc and copper deficiencies deliberately induced by sand culture technique for a number of important farm crops, and actual field deficiencies of these two trace elements have now been diagnosed in a number of apple and pear orchards. For pears, a shortage of copper is now recognised as serious, but foliage spraying with a 0.05 per cent copper sulphate solution provides a cure. On the other hand borax, whether foliage sprayed, tree-injected, or soil dressed, will not cure the bitter pit disease of apples though this was once believed to be a consequence of boron deficiency. The functions of molybdenum, iron, aluminium, and manganese in plant nutrition have been further studied and reported. It is doubtful whether any research centre in Europe is more widely and thoroughly investigating the metallic trace nutrients than Long Ashton under the leadership of Professor T. Wallace.

There are reports on new fungicides for apple-scab, important enough because some varieties of apples and pears are damaged by lime-sulphur, but doubly important now that sulphur is a precarious material. Promising results under British orchard conditions have been obtained with glyoxalidines and a phthalimide compound. Here, too, and perhaps surprisingly to those who do not know that Dr. H. G. H. Kearns combines entomology with engineering, is the verbal and photographic 'blue print' for a low-volume sprayer and duster that enables crops and plantations to be treated without the transport or availability of large supplies of water, an invention of very great importance to the colonies.

Research at Long Ashton is not, however, confined to the production of bigger crops and their protection from insect or fungal attack. The qualitative effects of soil treatments upon crop composition are studied. If one department has shown that nitrogen supply produces bigger blackcurrant yields, another—the Fruit Products section—has shown that the vitamin C content of this fruit falls as the nitrogen applications increase. The rate of decline is not serious and it is a better nutritional gain to secure a bigger crop from nitrogen fertilisation than to take a smaller crop without but higher in vitamin C content per lb. of fruit. Nevertheless, further research may establish an optimum nutritional point for nitrogen treatment or, alternatively, it may be found that the supply of other nutrients satisfactorily offsets the tendency for high nitrogen levels of feeding to reduce the vitamin content of the crop.

All this—there are 23 original papers in the report apart from the general introduction and survey—has flowed from farmhouse cider. The work of Long Ashton may to-day be funded by the State, and the wide range of subjects studied determined by the Agricultural Research Council and the Department of Scientific and Industrial Research, but its origin was the private decision of a limited number of people who felt that some independent research upon cider-making and cider fruit would 'pay.' This modern centre is an outstanding example of the old principle that research ventures often produce a high return that cannot be foreseen at the outset.

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Notes & Comments

Steel Production and Prices

RAW material shortages seriously affected the output of steel in July and production fell to an annual rate of 13.317 million tons compared with 61.007 million tons in the previous month and 14.367 million tons in July 1950. The holiday period was partly responsible, but nevertheless, the decline from the month before was half a million tons more this year than last. There was a serious decline in stocks of scrap at steel works and blast furnaces at the end of June compared with last year, and ore stocks have hardly recovered from the low level to which they sank last spring. The British Iron and Steel Federation still remains confident that the 1951 target of 16 million tons of steel will be attained. Much must depend, however, on the building up of stocks of scrap and rich iron ore to make safe the winter output of steel. The increased prices of iron and steel products announced by the Ministry of Supply on 13 August were not really unexpected and seem, on the whole, to be justified by the rising costs. It is pointed out by the British Iron and Steel Federation that while dearer steel may tend to discourage the export of simple articles and to ensure that the available steel is used in higher-valued products, even so the British prices are still below those of other important countries which make and use steel. While it seems generally agreed that it is necessary to encourage imports, the arrangement is to continue by which duties are charged on steel when it comes into the country, but are paid for by means of a subsidy from the Ministry of Supply. No increases are apparently contemplated at present in the price of domestic scrap for steel making, although a better figure might tend to bring out larger supplies and thus help to offset the scarcity.

Automatic Control Systems

CHEMICAL and oil industries are probably far ahead of any others in the use and application of automatic control mechanisms. Two recent examples of chemical plant taking advantage of modern process control methods are the first stage of the Monsanto expansion project at Newport and Fisons' latest factory at Immingham. Process control is possibly even more advanced in the oil industry. At Shellhaven refinery, for example, a distillation unit with a throughput of two million gallons daily, nine distillation columns, and a final separation of crude oil into nine products requires 50 instruments and is operated by five men. For a modern catalytic cracker even more complex instrumentation is necessary. As many as 350 instruments may be used for measuring and controlling such variables as flow, pressure and temperature. The recent international conference at Cranfield on this subject received little publicity and future potentialities of automatic control mechanism remain hard to foretell. As *The Economist* points out, savings in labour have as yet hardly counted in deciding for or against controls. Their installation has rested more on controlling a highly complex process that could not be carried out manually than on doing a man's job without him. The scope of automatic control and its application to their own industries might well be examined by the industrial research associations. A first essential to development, however, is to gain greater interest of industry by explaining the possibilities in language that can be understood by the layman and enable him to appreciate the advantages of self control for machines.

'Ferralyst' Process

A NOTE on 'Ferralyst' sulphur recovery process reported in THE CHEMICAL AGE of 4 August 1951 has occasioned a certain number of inquiries about the process. One aspect of it that is brought into more immediate prominence at the moment by the recent forecasts of fuel shortages is the fact that the 'Ferralyst' recovery process reclaims the latent heat normally lost to the air in sulphur compounds present in waste industrial gases. Each ton of sulphur that goes up in smoke contains the equivalent of 6,000,000 B.Th.U. heat which is lost

when recovery is attempted by the oxide box method—a system which actually requires heat to operate it. Since the effluent from coke ovens contains yearly approximately 60,000 tons of sulphur, the fuel saving of reclamation would be considerable. Another important point about the process concerns the amount of steel used in the plant and the delivery time. Whereas an oxide box capable of desulphurising 6,000,000 cu. ft. of gas per hour uses 600 tons of steel with a consequent delivery date of 3-4 years, the 'Ferralyst' plant uses a mere 5 tons of steel and can be delivered in two to three months. In the face of a growing steel shortage and rearmament demands this factor becomes a decisive one. Other plants, too, contain less steel than the oxide boxes, but few, if any, *reclaim* the potential heat value of reduced sulphur present in gas, although one or two of them use it during the process. It is to be hoped that the cabinet committee on sulphur which was recently set up will be as quick to grasp the potentialities of this process as privately owned industry appears to be.

Invention and Application

A SERVICE to British industry was rendered by the Duke of Edinburgh in his presidential address to the British Association when he drew attention to how often the pioneer work carried out in this country was allowed to be brought to fruition elsewhere. Many instances could, unfortunately, be quoted of the considerable lapse between pure invention and its development, while practical applications were carried out abroad—notably by America and Germany. As the Duke said, it is a laudable ideal, no doubt shared by most scientists, that all great discoveries and inventions should be made available for the benefit of mankind, as is now habitually done in the field of medicine. This does not excuse the failure to make the most of British achievements which are eagerly exploited overseas. Some explanation as to why application is more rapid in the U.S.A. may lie in the actual difference between the structure of industry in the two countries. British industry today is largely monopolised while American is still highly competitive. Genius must be the source of scientific invention, but its application remains dependent upon capital. Venture capital, as the recent statement by the Federation of British Industries emphasised, is the lifeblood of enterprise.

A Royal Alchemist

WITH the British Association meeting centred this year in the city of Edinburgh, it was fitting that Professor John Read, F.R.S., should devote some of his fascinating discourse on 'Alchemy and Alchemists' to the part played by Scotland in the humanistic transition of chemistry from the magic and mysticism of alchemy. The fact, too, that the Duke of Edinburgh is the third member of the Royal family to hold office as the association's president adds interest to the recollections of the mediæval kings and princes who were attracted by science. Of these, King James IV (1488-1513) must be regarded, according to the standard of his day, as an enlightened amateur. This monarch, who was learned in the art of medicine, is reputed in his desire for practical experience in surgery and dentistry to have paid fees to his patients. Under the inspiration and direction of his alchemist, John Damian, Abbot of Tungland, an ingenious and personable foreigner who had been attracted to the Scottish Court from Italy or France, James IV established at Stirling Castle, about 1500, what may well be regarded as Scotland's first scientific laboratory. In his book 'Humour and Humanism at Chemistry', Professor Read gives an intriguing list of the prices of alchemical materials and apparatus used and of some of the personnel employed, including 'one boy that kepit the furnes fire.' It is certain that the king frequently visited the laboratory to take part in the work. Damian, having failed to make gold, turned to artificial flight. About 1507, with movable wings he endeavoured to take off from the lofty battlements of Stirling Castle on a flight to France, but 'shortlie he fell to the ground, and brak his thee bone.' During his convalescence reports state that James IV frequently played cards, dice and other games with his alchemist, the monarch's losses being revealed in the accounts of the Lord High Treasurer!

The British Association

Papers Read in the Chemistry Section

The following is an extract from 'A Hundred Years of Organic Chemistry,' by Professor A. R. Todd, F.R.S., read in Edinburgh, on 9 August.

THE century 1851-1951 has been an eventful one for organic chemistry. Indeed it has seen science grow from a rather confusing and empirical body of facts into one of the most systematic and fascinating of the sciences, and one on whose progress, moreover, many of the amenities of our modern civilisation depend.

1851 might almost be regarded as a turning point in organic chemistry, for major developments destined to shape the whole course of the science were at hand. It will be recalled that early in the 19th century Berzelius had defined organic chemistry as the chemistry of substances produced by living matter in contradistinction to the inorganic substances of mineral origin. There were certain striking differences between the two types, and in the mind of Berzelius, as in those of his contemporaries, these were associated with the concept of a vital force. Wöhler's laboratory synthesis of urea in 1828 is generally believed to have sounded the death knell of the vital force theory, but in fact it survived for long after that, and it still rears its head in the famous text-book of Gmelin (1854).

Carbon Compounds

In the years that followed Wöhler's discovery, however, Liebig and others had shown that the organic compounds all contained carbon, and that carbon compounds with similar properties could be obtained from non-living services, for example, coal tar. So it gradually came to be recognised that organic chemistry was in fact synonymous with the chemistry of the carbon compounds, and attention was directed to the understanding of carbon chemistry, since it was clear that until such an understanding was obtained little progress was to be expected in studying the chemistry of living matter.

By 1851 the efforts of many chemists had produced a substantial body of factual knowledge, but despite type theories and radical theories there was no really satisfactory theory of valency which could correlate the facts and establish the inter-relationships of organic compounds. In 1852, E. Frankland made the first clear statement of the idea of valency or fixed combining power of an element. This was a great step forward, and it was followed in 1858 by the work of Kekulé and Couper, who independently put forward a theory of molecular structure based on the quadrivalency of carbon, and the capacity of carbon atoms for joining together in chains; they showed how molecular constitution could be represented diagrammatically in graphic formulæ and could predict the existence of isomers. That more isomers did in fact exist than were allowed for by this theory was, however, clear from the earlier work of Pasteur who had shown that two optically active tartaric acids existed.

Professor A. R. Todd

This was clarified in 1870 by Van't Hoff and Le Bel who added to the Kekulé-Couper ideas the concept of the tetrahedral carbon atom, and thereby introduced the idea of space or stereoisomerism. With this the whole subject was placed on a firm basis, and on these theories virtually the whole of the modern science arose. Only in comparatively recent years have alterations in the basic ideas of molecular structure come from physics, through knowledge of the electronic structures of atoms, but even these

new ideas have not altered the essential applicability of theory laid down between 1850 and 1870.

Armed with this understanding of structure, the study of the carbon compounds flourished exceedingly, and by the early 20th century a vast number of such compounds were known and methods of synthesis and analysis had been developed in great variety. During this period, too, began the rise of the great organic chemical industry—producing dyestuffs, starting from the initial aniline dye of Perkin, explosives, and so on. This rise of an industry notable for its closeness to the advancing front of science has continued, until today it produces not only dyes and explosives, but plastics, detergents, photographic materials, drugs, fabrics and a multitude of other things which we accept without question as part of everyday life—there are indeed few of the material comforts of life which do not owe something to organic chemical industry.

The 20th century has seen however, a remarkable development in our knowledge of chemistry in relation to living matter. During the latter half of the 19th century organic chemists paid scant attention to this side of their subject and even biochemists—those concerned primarily with the nature of the processes going on in living matter—were relatively few. It is only in this century that great strides in biochemistry have been made.

From the organic chemist's viewpoint this was inevitable. The materials found in living matter were too complex for him to study with success until he had mastered the groundwork and developed methods for studying carbon compounds in general. This mastery came from the work of the late 19th century, and as the 20th begins we can see the beginnings of a move towards the goal of the early organic chemists, in the work of Fischer, Willstätter and others on the proteins, purines, sugars, natural colouring matters and enzymes.

This movement has grown continuously, receiving enormous impetus through the development of micro-techniques, which enable work to be done with tiny quantities of material. In the past 25 years it has given us most of the spectacular achievements of organic chemistry in the structural elucidation and synthesis of hormones, vitamins, alkaloids, natural colouring matters, etc., and indirectly of the synthetic drugs. Parallel with it have come the developments in the understanding of the finer details of molecular structure and reactivity associated with the names of Lapworth, Robinson, Pauling and Ingold. The welding together of the results and ideas emerging from those two fields of endeavour promise still more striking triumphs for organic chemistry in a future which should be as fascinating as its past.

Chemistry in Metal Extraction

ON 14 August, Dr. F. D. Richardson, of the Imperial College of Science and Technology, read a paper on 'Chemistry in Metal Extraction' to a joint meeting of the Chemistry and Engineering sections of the British Association, of which the following is an extract:—

There are three main steps in the winning of a metal from its mined ore—concentration, smelting and refining. Chemistry enters into all of these, but this paper is restricted to the chemistry of metal extraction at high temperatures.

The systems which are most important in this connection are molten metal and molten slags and mattes. Our knowledge is weakest on the last two, so that research is particularly required on the chemistry of molten silicates, oxides and sulphides, and their mixtures. Since the nature of liquid metal and slag solutions is only now becoming clear, it is worth reviewing the picture of them which has so far been developed by the application of physical chemistry.

A molten metal consists of closely packed metal atoms, each of which interacts strongly with its eight or so nearest neighbours. The liquid resembles the solid closely, and differs from it mainly in lacking the long range order peculiar to the crystalline state. Other elements dissolved in metals can be pictured as foreign atoms dispersed among the metal atoms and also interacting strongly with them. They may be distributed uniformly throughout the melt or they may cluster together in some degree. There is evidence, for example, that chromium and oxygen atoms cluster together when dissolved in liquid iron, and so influence each others behaviour.

Molten silicates consist of disordered three-dimensional networks of tetrahedral silicate groups (SiO_4). These groups share corners with one another via Si-O-Si 'bridges'. Every corner is shared in the case of fused silica, which has a high viscosity as a result. These bridges can be broken by the addition of metal oxides. As sodium oxide, for example, is added to fused silica, the chains in the network become shorter and shorter, with a corresponding decrease in viscosity, until at the composition $SiO.2Na_2O$ no corners need be shared. Thereafter the addition of more metal oxide gives rise to oxygen and metal ions dispersed between silicate tetrahedra.

As much confusion has arisen from theories of the formation of various kinds of molecular compounds in liquid slags, it needs to be stressed that no precise molecules can be identified in such melts. The only entities which can be recognised as having a distinctive existence are the metal ions, the silicate tetrahedra which carry a net negative charge and may be bridged together in varying degrees, and the excess oxygen ions.

The rates of reactions between slags and metals are not controlled by the chemistry of the processes which take place at the interfaces between them. Diffusion of reactants and resultants to and from the interface it rate-controlling and diffusion in the slag is usually far slower than in the metal. The rates of refining processes with slags are thus dependent on stirring conditions and the diffusion coefficients of the participating entities in the slag.

Liquid Systems Elucidated

The research which is being done to-day, is designed to elucidate the nature of these liquid systems still further. The thermodynamic properties of slag and metal solutions are being measured by gas-slag, gas-metal and slag-metal equilibrium studies. The atomic nature of metals and slags is being solved by measurements of viscosity and diffusion and, in the case of slags, of electrical conductivity and ionic transport as well.

The physical chemistry of metals and slags is a development of the past 25 years. During this time it has mainly been related to iron and steelmaking, and to such new and costly metals as titanium, zirconium and uranium. The latter are now being produced by methods which spring directly from chemical research. So far as iron and steel and the older metals are concerned, research has been aimed at establishing the physico-chemical background of existing processes. These have been successfully developed by empirical means, so that in a sense the research chemist has here been trying to 'catch up with' the practising metallurgist. The older metal industries do not therefore show any dramatic advances, resulting from the application of physical chemistry. They do, however, show many improvements which have followed from a better understanding of what goes on in the furnaces of the smelter and refiner.

Sulphur Iron

Recent work on sulphur in iron-making provides a typical example of the way in which such improvements can come about. Although the scarcity of sulphur may be a headache to the Government and chemical industry, a surfeit of this element causes a headache to the metallurgist and especially to the makers of iron and steel. The sulphur in iron ore and coke gets into iron when it is made in the blast furnace. Although the majority passes into the slag, which carries around 1 to 2 per cent sulphur, about 0.1 per cent is left in the metal. This causes difficulty in steelmaking as it has to be removed as far as practicable, by the use of large quantities of a strongly basic slag.

Fundamental thermodynamical studies have lately shown that under normal conditions a sulphur atom can only enter a silicate slag of constant composition by displacing an oxygen atom. The equilibrium between sulphur and oxygen in slag metal and slag gas systems may thus be represented by the equations:—

(S'') slag $+[O]$ metal $=(O'')$ slag $+[S]$ metal

(S'') slag $+ \frac{1}{2}O_2 = (O'') \frac{1}{2}S_2$.

It follows that in gas-slag systems, a high oxygen pressure tends to push sulphur out of the slag into the gas. It has also been shown that the partition of sulphur between slag and metal, which can be obtained under equilibrium conditions in the laboratory, is much more favourable than that attained in the blast furnace. This is apparently due to inadequate mixing between slag and metal.

A two-fold possibility of practical importance clearly emerges from these fundamental researches. It may become possible to make

lower sulphur pig-iron by mixing slag and metal in the ladle after tapping—an additional operation but one which uses materials already available and at the right temperature. It may also become practicable to recover the sulphur present in the molten slag by blowing air or oxygen through it. Although only 1-2 per cent is present, it is readily evolved as sulphur dioxide, which could be used for making sulphuric acid. The 7,000,000 tons of blast furnace slag made annually in Britain are thus a potential source of 100,000 tons of sulphur.

Synthetic Polymers

SYNTHETIC polymers form the basis of the three industries of ever-growing importance, namely synthetic plastics, fibres and rubbers, and their growth of manufacture and of uses has been one of the most spectacular developments in the chemical industry in the last decade, said Dr. J. C. Swallow, Imperial Chemical Industries, Ltd.

These industries, continued the doctor, had a common scientific background, but different technologies in application, and were all based on polymers which were macro-molecules made by the process of polycondensation and polymerisation. Those materials which had been selected for large-scale production represented a selection from a large number of synthetic polymers produced in the last 20 years.

To obtain a general picture of synthetic polymers they could be divided into three overlapping zones, namely the rubberlike, the amorphous or glasslike, and the crystalline and fibre-forming zone, from which it was possible to appreciate how their properties were related to their structural features. It is also possible to see what chemical changes were necessary to bring a polymer from one zone to another, and a number of examples could be quoted, such as the chemical modification of nylon, the chlorination of polythene, and so on.

Crystalline polymers formed the basis of a number of new synthetic fibres such as nylon and 'Terylene' which were made by the new technique of melt spinning. Within such a classification of synthetic polymers it was possible in certain cases to synthesise deliberately a polymer with the properties required for a specific application. There were, however, other methods of modifying structure without altering the skeletal chain, and in the field of fibres this was done by blending natural fibres with synthetic ones,

The Duke of Edinburgh after receiving the Honorary Degree of Doctor of Laws from Edinburgh University. The ceremony was a prelude to the inaugural meeting of the British Association for the Advancement of Science of which the Duke was president. Immediately behind him is Sir Edward Appleton, vice-chancellor and principal of Edinburgh University, and to his right, Sir Harold Hartley, president in 1950. Membership for this meeting passed the 4,000 mark, the highest for any previous gathering of the association, with the exception of the centenary occasion in London. Members from over 18 countries attended. *(By courtesy of the* 'Scotsman')

or even synthetic fibres of different kinds together.

Also, by varying the degree or orientation of a long chain molecule the physical properties of fibres could be altered to give high tenacity and low elongation, or lower tenacity and greater elongation more akin to the wool fibre. The morphology of solid polymers was therefore of increasing importance in the technical application of polymers.

With the great range of possibilities in polymeric chemistry, what were the limiting factors which prevented the production of these new materials in sufficient quantity for all our needs? The lag of seven to 10 years between the discovery in the laboratory and the successful production on an industrial scale, which existed before the war, had still to be faced. Further post-war economic difficulties, and the orderly introduction of new materials into modern economy represented one of the more difficult tasks facing chemical industry, and the industries which used these products to obtain new technical effects

Raw materials for production of synthetic polymers were, on the one hand, coal from which was derived benzene, the basic raw material for the thermosetting group of products, nylon and polystyrene. Other plastics such as polythene and the synthetic rubbers, required the olefins which were most conveniently produced from the cracking of oil, a new and growing development in the aliphatic industry.

Petroleum Chemicals

ONE of the fastest growing industries in the U.S.A. now is the making of chemicals from petroleum and natural gas. More than $110 million is at present being spent annually on research work on the expansion of petrochemicals. In the U.K. too, the petroleum chemical industry as typified by the Fawley oil refinery to be opened at the beginning of next month, is developing rapidly

These facts lend particular interest to the address on 'Petroleum Chemicals' given by Dr. F. Roffey, controller of research and development, Distillers Co., Ltd.

The petroleum industry, said the doctor, could be defined as that section of chemical industry which derived from petroleum or natural gas as raw material, and in general terms had its main influence in the large scale production of aliphatic rather than aromatic products. It was in a sense complementary to the much older coal-tar industry, although many important developments were based on the intermediates derived from both.

Progress in the petroleum chemical industry had been made in a relatively short time —essentially since the middle twenties. Major developments in derived chemicals had taken place in America, but this was really only natural as the U.S.A. held a predominant position both as a producer of crude oil and natural gas and as a user of various refined oil products.

Britain, however, had made considerable progress, particularly since the war.

Lines of development were shown by charts indicating the two main steps between raw material oil and end-product chemicals.

The first step was essentially the responsibility of the oil industry, namely, the breakdown of any given feed-stock into its component hydrocarbons or closely related groups of hydrocarbons, this operation being carried out in the refinery by a combination of cracking and distillation. The second stage consisted of synthesis of the required chemical end-products from the individual components of the refinery operations and was the task of the petroleum chemical side.

Main raw materials used on the purely synthetic side of the industry were the olefinic constituents of cracked oil, namely ethylene, propylene, the butylenes and butadienes. From these were derived, either directly or by condensation with selected aromatics such as benzene and toluene, the majority of the larger tonnage end-products. These included synthetic ethanol; glycol, isopropanol, which in turn was converted to acetone; higher alcohols and ketones; and some highly important bases for the polymer and detergent industries such as styrene, phenol and the condensate of polymerised propylenes with either benzene or toluene.

More recent developments based on direct oxidation of natural gas to give a wide range of oxygenated compounds were summarised by the speaker, together with the modified Fischer-Tropsch process based on natural gas which aimed at large-scale production of both petrol and oxygenated chemicals. Production of acetylene and hydrocyanic acid by petrochemical processes was reviewed.

The Epicuticle of Wool

Investigation of Its Chemical Nature

ELECTRON microscopy is quite a recent field of wool research, the first papers and electron micrographs having been published in 1943 by Zahn in Germany and by Hook and McMurdie in the United States. Whereas the ordinary microscope has a useful magnification of about 1,000, the electron microscope is capable of revealing particles as small as a hundredth of the wave-length of light, thus allowing fibres to be examined at a magnification of about 100,000. Electron microscopy is therefore a valuable tool for investigating changes in the surface structure. It is noteworthy that significant contributions to knowledge of the fibre have already been made by most wool research institutes which are equipped with electron microscopes.

The Epicuticle

Important consequences may result from the discovery of a thin membrane, which is believed to be partly responsible for the surface properties of wool. This membrane is invisible under an optical microscope and has been termed the 'epicuticle'.

In a paper delivered to the Journal of the Society of Dyers and Colourists, N. Gralén points out that the textile properties of fibres are to a large extent associated with their surface structure. It is believed that most textile fibres have a cuticle which is different from the rest of the fibre. The primary wall of a cotton fibre is physically different from the secondary wall and probably is also chemically different.

Due to the method of extrusion and coagulation artificial fibres often have a skin, the difference being mainly physical. It has been shown that wool has a cuticle which is both chemically and physically different from the rest of the fibre. The surface of wool has a scaly appearance, which can easily be observed under an optical microscope.

Both nylon and artificial silk, which are considered to be very smooth fibres, have frictional coefficients which are considerably higher than those of wool. During an investigation of wool fibre in the electron microscope, workers at the Swedish Institute for Textile Research found what they believed to be the explanation of wool's low coefficient of friction. After dissolving wool in a 1 per cent sodium sulphide solution, Lindberg, Philip and Gralén noticed that a faint opalescence was left in the solution and did not disappear, even after a fairly long period.

This opalescent residue was centrifuged down, washed and investigated in the electron microscope. It proved to consist of very thin membranes, mostly folded, of fairly uniform thickness. These membranes were probably identical with a thin membrane resistant to trypsin digestion, which was found in 1946 by Mercer and Rees during an investigation of the structure of the cuticle cell by electron microscopes.

Subsequently the Swedish investigators found that the same membranes were obtained from chlorinated wool simply by shaking the wool with water. After treatment with chlorine and shaking with water, the wool still retains its character under the microscope and even its scaly appearance. In electron microscope replicas, the chlorinated fibre shows a striated structure in the fibre direction. These striations are not found, or at any rate are much less obvious, in untreated fibres. This method of preparation indicates that the membrane is located on the external surface of the wool fibre.

Cuticle forms a fairly large proportion of the wool fibre, estimates given by various authorities ranging from 2 to 10 per cent. The thickness of the membrane, or 'epicuticle' has been measured by means of the ordinary shadow casting technique for the electron microscope, and was found to be 50-250 Å. From these figures it is evident that the membrane is only about 0.1 per cent of the whole fibre, so that it is not the cuticle itself, though it is certainly a portion of the cuticle. Before the findings of the Swedish workers the existence of an epicuticle or a similar membrane was actually predicted from diffusion phenomena occurring in dyeing and staining.

Chemical Resistance

The epicuticle is highly resistant to chemical treatment. The methods of isolation have shown its resistance to chlorine and sodium sulphide, while its resistance to strong acids and to enzymes is also shown. In later experiments Lindberg, Philip and

Gralén found that prolonged treatment with alkali or sodium sulphide resulted in perforation of the membrane, which was obviously the beginning of its destruction. Its resistance is much greater than that of ordinary wool keratin, however, from which the investigators conclude that it is not an ordinary protein.

So far the exact composition of the epicuticle is unknown. Various suggestions regarding its chemical nature have been put forward, but none of them has proved correct. The structure is certainly not cellular. Gralén points out that the chemical resistance might indicate a carbohydrate or chitin-like structure, while another possibility is that it might be a condensation product of waxes originating from the same glands as the wool wax. A chemical analysis of the epicuticle is being undertaken.

Although highly complex, knowledge of the cuticle and of its components and structure has been greatly extended by several studies undertaken since the war with optical or electron microscopes. Evidence obtained from electron micrographs led Mercer and Rees to postulate that the structure of the cuticle cell consists of a smooth and featureless outer layer, k_1, which is digested by trypsin, and an inner layer, k_2, which is highly resistant to trypsin digestion. The latter layer is a pitted, honeycombed structure with ridges and folds running parallel to the pores.

Polystyrene Casts

These conclusions are independently supported by electron micrographs obtained by Swerdlow and Seeman of an entirely different preparation. The latter investigators made polystyrene casts of the surface of unabraded and abraded wool fibres. Electron micrographs of the impressions show that the unabraded cuticle cell is covered with a smooth lacquer-like coating corresponding to the k_1 layer. When this coating is abraded away, a layer is revealed which has a corrugated, ribbed structure, similar to that of the k_2 layer of Mercer and Rees.

German workers have isolated a rather thick membrane (about 5 per cent of the wool), which is believed to be located between the cuticle and the cortex. This 'subcutic' is obtained by treatment of the wool with formaldehyde and phenol at 130°C., followed by pancreatic digestion. In this way the cortex is dissolved or digested and a tube is left, which is the assumed subcutis.

Lindberg and his associates have shown that the tube has scale edges like the cuticle, and that a thin membrane quite similar to the epicuticle can be isolated from it by chlorine treatment. The epicuticle, however, is partly thickened by hardened protein residues, which are held to belong to a layer intermediate between the epicuticle and the scales proper. The investigators termed the intermediate layer the exocuticle and the scales themselves the endocuticle. The exocuticle can be digested with trypsin, leaving the scales as a vesiculate structure (the k_2 layer of Mercer and Rees). The scales adhere so strongly to each other that the cuticle cannot readily be dissected by a micromanipulator into its component scales. This fact, together with the fact that the cuticle or parts of it can be isolated as a tube, have led to a theory that the scales may not be single cells, but that the cuticle may have the shape of a folded sheath.

Easily Damaged

These studies of the structure and components of the cuticle may lead to practical developments in the processing of wool. If the epicuticle formed a continuous sheath around the whole fibre, it is probable that no dye could penetrate the fibre. Being very thin, however, epicuticle is easily damaged mechanically, either by the sheep when rubbing itself against rocks or trees or during the processing of the wool.

It has been confirmed by Lindberg that damage to the epicuticle produced by treatment with alcoholic potassium hydroxide gives more rapid and even drying. Removal of the epicuticle without further damage to the wool would undoubtedly yield a fibre which could be more easily dyed.

Several microscopical tests for damage to wool certainly depend on the existence and removal of the epicuticle. This is true of several staining tests, such as the Pauly test and the methylene blue test. When the epicuticle is damaged, the dye penetrates through the holes and stains the keratin of the fibre. Of particular interest is the well-known Allwörden test, which causes blisters in intact fibres. These blisters do not appear on alkali-treated or otherwise damaged wool.

In this test the epicuticle acts as a semi-permeable membrane. The chlorine readily

diffuses through the epicuticle and reacts with the underlying exocuticle. The soluble macro-molecular products formed exert an osmotic pressure on the membrane. The difference in refractive index between the inner and outer solutions render the blisters visible, even if the membrane itself is too thin to be observed. From its behaviour in this test Gralén concludes that the epicuticle sticks to the rest of the cuticle especially well along the lines or ridges, which partly coincide with the scale edges and partly run in other directions. The test also shows that the epicuticle is fairly extensive, so that swelling and also some stretching of the fibres can occur without bursting the thin membrane.

Gralén also draws attention to the rôle of the frictional properties of the fibre in spinning wool and on the wearing properties of wool fabrics. It is known that chlorinated fibres give rise to a smaller number of ends down in spinning, due to increased friction between the fibres. Wearing properties might also be enhanced by reduction of the fibre slippage.

Electron microscopy has opened up new possibilities for wool technology, but further research is still necessary to provide a more complete picture of the chemical and physical structure of the cuticle.

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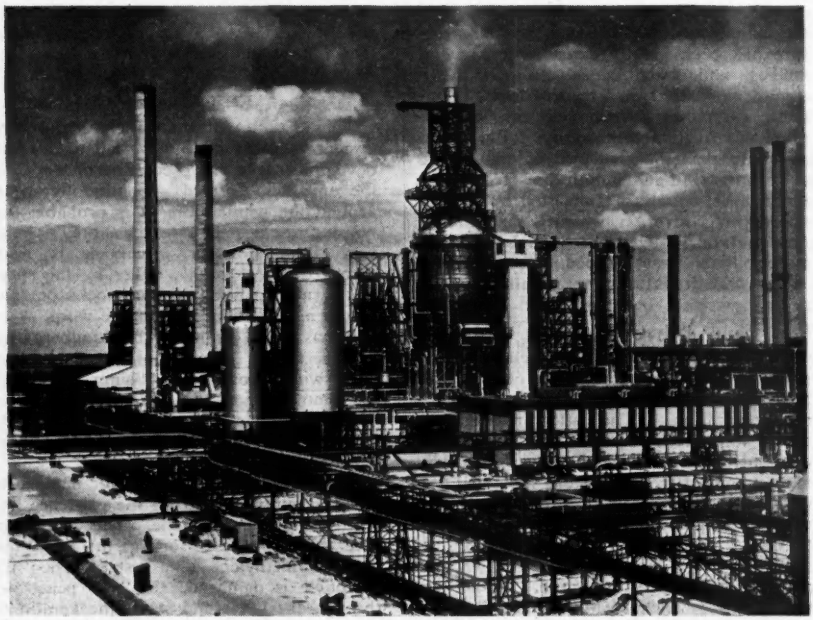
Acknowledgment is also made to the Scientific and Technical Department, International Wool Secretariat.



The first modern-type catalytic cracking unit to be constructed in Europe. A view of Shell's Pernis refinery near Rotterdam which has just been completed and is due to come into full operation shortly with a capacity of about 1½ million tons a year. From left to right can be seen the stack of the furnace (height 196 ft.), catalyst hoppers and, at the top, the conveyor for the catalyst. The white rectangular structure in the centre is the regenerator with the lift and, right, the fractionating column. The low building in the foreground is the compressor house

Mellon Institute Research

Many Fields Investigated

THE report on scientific researches carried out at the Mellon Institute of Pittsburgh, Pennsylvania, during 1950-51 contains many interesting items carried out by the fellowships. The Mineral Products Fellowship, now in its fifteenth year of progressive research on the recovery and utilisation of finely-divided siliceous wastes from plate-glass plants, has achieved the evolution of successful industrial processes which have resulted in the development of products that have found wide application in diverse fields. This potentially valuable waste material, consisting essentially of silica and glass with a particle size nearly 100 per cent less than 325-mesh, discarded in rivers or vast dumps at considerable expense, can now be advantageously retrieved and utilised.

The Ceramic Chemicals Fellowship has been conducting research into the development of better vitreous enamels for the past 17 years. Since 1945 it has been engaged chiefly in investigations concerned with the formulation of titania-opacified cover-coat compositions, the results of which have contributed to the large commercial production of frits of high quality used in the preparation of enamels for the household and commercial appliance industries.

Fundamental Reactions

For many years enamel compositions were formulated from the experience of a long-established art. The application of the principles of chemistry to the investigation of these complex compounds has made possible a clearer understanding of the characteristic effects of the major and minor ingredients on their properties, and a fair degree of predictability has been attained.

Much of the work of the fellowship during 1950-51 has been devoted to an extension of studies of fundamental reactions. This research has moved towards the formulation of compositions which produce enamels maturing at relatively low temperature and which can be fired at higher temperatures without appreciable change of opacity and colour value, and, regardless of firing temperature, possessing a high degree of acid resistance.

As a part of an investigation into the improvement of the thermal shock resistance of enamels for gas and electric range tops and for cold-wall refrigerators, many determinations of thermal coefficient of expansion have been carried out. The rate of penetration of hydrogen through steel plates prepared for enamelling by various methods has been ascertained by electrolytic and pressure procedures.

At the same time, ideas for the further improvement of groundcoat and cover-coat enamels have been promulgated, and the results of the work translated into industrial production. In particular, the Fellowship has aided in the development of two series of ground-coats which make possible the continuance of the enamel industry and co-operation with the National Production Authority by limiting or even eliminating the use of cobalt oxides and other scarce materials.

Improved Sintering Processes

The Agglomeration Fellowship was established in 1949 by the American Iron and Steel Institute, for the purpose of evolving improved blast-furnace sintering and agglomerating processes. This work has a large present application since sinter production now easily amounts to more than 20 per cent of iron-ore shipments from the Lake Superior ranges. It also has far-reaching significance because of the growing importance of agglomeration in the processing of new iron-ore reserves.

This Fellowship has completed a comprehensive survey of modern American sintering practice as a means of ascertaining facts and of forming the basis for a research and development programme. Many opportunities for improvement of sinter properties and production methods have been disclosed. Three factors were found to be of importance in the situation. First, the use of sinter in the blast furnace has failed in many cases to give the results expected or desired of it. Secondly, the properties of present sinter need improvement according to the ideas of blast-furnace operators. Moreover the properties of 'good' sinter require better definition. Thirdly, many aspects of sinter-plant operation show possibilities for major improvement.

The Fellowship is proceeding with a

research programme based on these findings. Quality control test methods for measuring sinter properties are being adapted and devised It is hoped that these methods will assist plants in maintaining uniformity and also that they will indicate what properties of sinter are important in the blast furnace. Sinter will be produced experimentally in order to determine the effects of operating variables and to improve basically the properties of sinter.

The Multiple Fellowship on Acid Recovery, also under the donorship of the American Iron and Steel Institute, has since 1938 been researching into methods for utilising or disposing of waste pickle liquor, assistance to steel companies on pickle liquor disposal problems, and co-operation with public agencies in developing reasonable stream pollution abatement measures.

Pickle Liquor Disposal

Research on the recovery of manganese from low-grade ores with waste pickle liquor has resulted in reaction data useful in designing commercial operation of the process, and has pointed to prospects for an important technical simplification in its operation. The study of samples from the large deposit of low-grade ore in Maine, which had not been amenable to the original process, has been successful in developing a procedure whereby nearly 90 per cent of the manganese can be recovered with a solution of ferrous sulphate alone.

A preliminary investigation of the activation of certain clays with waste pickle liquor has indicated that agents for decolorising oils can be prepared. Research on methods for producing ferrous ammonium sulphate from pickle liquor has led to the development of a technically sound process. A patent was issued covering the Fellowship process for manufacturing pure ammonium sulphate and magnetic iron oxide from pickle liquor.

The possibility of expanding markets for ferrous sulphate has led to a study of the value of this compound for treating wool-scouring wastes. This investigation has already resulted in purification superior to that obtainable with the conventional acid-cracking process. This project may be expanded to include recovery to marketable products from this waste and definitely will be extended to the treatment of other types of waste waters.

The Multiple Fellowship on Chemical Storage at Pittsburgh, Pa., has been occupied with a heavy programme that has produced many accomplishments.

There has been unbroken sequence in the study of the best methods of storing various commercially important chemical substances. Forty-four different substances have now been investigated and separate reports are available for guiding their proper storage. These materials include the following: acetaldehyde, acetic acid, acrylonitrile, ammonia, ammonium nitrate, butadiene, butadiene and isobutylene, normal butane, butene-1, butene-2, *trans*-butene-2, benzaldehyde, calcium chloride, carbon dioxide, castor oil, caustic soda, chlorine, coconut oil, ethyl acetate, ethyl alcohol, formaldehyde solutions, 'Freons', gas oil, gasoline, hydrofluoric acid, hydrogen peroxide, isobutane, isobutylene, liquids and gases, magnesium oxide, methanol, methyl chloride, nitric acid, palm oil, propane, propylene, common refrigerants, sperm oil, styrene, sulphur dioxide, sulphuric acid, and turpentine.

The development of the 'Icosasphere' has received wide and very favourable notice not only in the U.S.A. but also in various foreign lands. During the past year many additional 'Icosaspheres' have been constructed, mostly for the storage of high volatility petroleum, other light petroleum products and sewage gas, and for vacuum service in the industries.

Evaluation of Steel Stresses

The research in evaluating stresses in steel structures of various types has been extended. A programme is under way to evaluate the stresses in large tubular elevated water-tank columns which cannot be calculated with certainty. One project is a full-scale test of such tank columns. A study of the literature on the subject of cylindrical shells used as columns has indicated that the wrinkling strength is affected by the length of radius of gyration ratio (L/ρ) as well as the thickness to radius ratio (t/r). Hence a programme has been initiated to investigate this phenomenon experimentally, by testing full-scale fabricated tubular columns with various values of L/ρ and t/r.

The Multiple Fellowship (Metal-working) of Pittsburgh has been investigating the double-drawing of low-alloy high-tensile steels by means of a triple action hydraulic press in conjunction with recording oscillographs, to define the most efficient die design and die sequence for this process of deep

drawing. Variables related to lubricants, temperature, reduction, drawing speed, and pressing tonnages were collected and studied. Cold reductions as high as 73 per cent of the original blank diameter were obtained without the conventional subcritical annealing. It is believed that these high-blank reductions were associated with the Bauschinger effect.

A statistical analysis of deep-drawing performance was also completed, to show the effect of the chemical and physical properties on the pressing characteristics of certain types of low-alloy high-tensile steels that were double-drawn in production.

Studies were also conducted to establish the physical properties of low-alloy high-tensile steels at elevated temperatures, so that specific properties could be evaluated to resolve any deviations which might occur at elevated temperatures in the double-drawing process. Chemical research was concluded on the effect of aluminium nitride nitrogen on the drawability of silicon-aluminium killed steels.

Experimental double-drawing tests were consummated on dry-type lubricants, which were applied to half-size drawing blanks for ascertaining the most suitable type of dry lubricant for production operations. Progress has been made on the hot-closure forming of deep-drawn products.

A special mechanism was devised to add filler metal in the inert-gas-shielded arc-welding process of ferrous and nonferrous alloys. The industrial success of this process has been demonstrated in the welding of silicon-bronze alloys.

Automatic Welding

Several automatic methods have been employed to weld hot-dipped galvanised steel sheet that would be suitable for pressure-vessel construction of the hot water storage heater design. While no definite conclusions have been affixed to a particular process, experimental work has been extended in this field of composite welding.

The Multiple Fellowship on Nickel of the International Nickel Company Inc. of New York, has continued its research on the catalytic behaviour of nickel, with special work on the nickel-sulphur system.

Supported Ni_3S_2 catalysts have been studied in the hydrocarbon-steam reaction in the presence of sulphur compounds. A demonstration pilot plant for continuous hydrogenation over fixed-bed nickel catalysts was used in the experimental treatment of a variety of oils and organic chemicals. Some work was started on the regeneration of spent nickel catalysts and on nickel recovery from catalyst residues to help assure efficient use of the available supply.

Twenty-two new nickel compounds have been prepared by The International Nickel Co.'s Nickel Derivative Fellowship, and their properties are being determined in connection with the search for new industrial applications. Those compounds with the requisite oil solubility are being studied as lubricant additives in comparison with analogues of other metals. The data obtained so far suggest that some of these compounds merit further investigation as detergent-type additives.

Arsenic Consumption

With the Fellowship (Arsenic) supported by the American Smelting and Refining Co., the aim has been to expand the consumption of arsenic either by uncovering new uses or by reviewing uses proposed or developed in the past that have not found commercial acceptance.

Experiments were conducted to determine what part arsenic might play as a corrosion inhibitor in any system using sulphuric acid in contact with steel, such as pickling or sulphonation reactions. A critical survey of the anti-fouling characteristics of arsenic compounds and alloys was under way for some time. An investigation of the possible use of arsenic in admixture with asphaltic or coal-tar road materials as a means of controlling weed damage to secondary roads, driveways, etc., was begun. The rôle of arsenic compounds as anti-corrosive agents in paints was studied and a number of other problems were under consideration.

This year marks the 20th anniversary of the Multiple Fellowship on Sulphur, sustained by the Texas Gulf Sulphur Co., of New York. Shortly after its formation, this company started its first Fellowship. The initial researches were concerned with plant problems, such as handling and storage of brimstone, decolorisation of the crude product, development of analytical procedures, treatment of the fresh water supply for the Frasch process, and treatment of trade wastes, particularly bleed water. Also, types of equipment relating to pan or shelf sulphur burners were developed.

Subsequently, so as to locate and cultivate new markets for brimstone, investigation

was given to finding some novel uses. Sulphur cements, which came from this research, have been employed as a jointing material for bricks in acid-proof tanks, as a tank-lining resistant to acids, as a jointing agent for brick roads, clay products such as sewer pipe, and cast-iron water pipe, as a lining in pipes, as traffic markers, and as expansion joints on roofs. The greatest successes were obtained in the fields of acid-proof masonry construction and jointing water mains.

Sulphur-Impregnated Wood

Sulphur-impregnated wood was also developed to give products of greater strength, hardness, and density, possessing a higher dielectric constant and showing increased resistance to weak or dilute acids. Certain of these products were used in the early days by amateurs in the construction of radio sets. Pulp and paper products were also impregnated with brimstone. Here the sulphur enhanced the wet and dry strengths, increased the stiffness, reduced wick action, and improved stability in humid and acid atmospheres. The impregnation of paper was adopted in the manufacture of spools and spindles for the textile trade and in the making of paper dispensers.

An ethylene-sulphur rubber constituted another accomplishment. This material proved valuable as a plasticiser for sulphur cements, as an expansion joint material, and as a rubber substitute. The success of the GR-S programme prevented a full-scale development.

Investigation was also accorded to the agricultural uses of sulphur. A co-operative effort with others led to a spray-type burner from which the heat was recovered. The development of this combustion unit assured a smooth and efficient burning operation. And, too, during much of this time, considerable work was devoted to methods of facilitating the use, handling, and storage of sulphur.

Because of the need for basic data, articles have been published on the thermodynamic properties of sulphur and sulphur dioxide and on the viscosity and the thermal conductivity of sulphur vapour. Other properties of sulphur are being continuously probed, to gain insight into all important characteristics of the element.

The Multiple Fellowship on Technical Glassware has been concerned entirely during the last twelve months with investigating silicones. Very early in this research it became apparent that the silicone fluids, which were the first useful compounds to be developed, had important military applications. As a result of intensive efforts the growth from laboratory investigation to commercial production was accomplished within the short period of three years.

These fluids, and products developed from them, proved to be unique, for they showed unusual and useful properties, such as low and high temperature applicability (−40° to + 500°F.), small change of viscosity with temperature, water repellency, and good electrical properties. They were therefore applied as damping fluids and lubricants, for waterproofing of ceramics and electrical devices, and, in compounded form, as sealing materials for aviation-type spark plugs and for electrical connectors. They have later found wide use as release agents in the moulding of plastics and rubber and in certain types of die casting. Their application in automobile and furniture polishes is proving useful, and further demonstrates the surprising versatility of these fluids.

Production of 'Silastic'

Shortly after production was well under way, further Fellowship laboratory investigation resulted in the development of a rubber-like material. Again, commercial production followed rapidly, the product being named 'Silastic'. It proved to have rubbery properties over a temperature range of −40° to +500°F., and quickly found application at high and low temperatures as an electrical insulator, as a gasketing and sealing material, as flexible tubing, and for many purposes at temperatures too high or too low for conventional natural or synthetic rubber. Supplemental work bettered the physical properties of tensile strength and abrasion resistance, and the low-temperature properties were improved to the point where it is now useful at −100°F.

The development of the fluid materials has helped pave the way for a surprisingly large variety of materials having industrial value. These comprise high- and low-temperature lubricants, anti-foaming compounds, anti-silking agents for paints, resins (for both impregnation and coating), moulding compounds, and laminating materials. All these products are finding increasingly broad industrial acceptance and application.

[continued at foot of page 226

Copper in Foods

Harmless within Certain Proportions

NO exception need be taken to the presence of traces of copper in foods and beverages provided they are kept within recognised limits. This is the conclusion of the Metallic Contamination Sub-Committee of the Food Standards Committee of the Ministry of Food in its report published last week.

Copper, the report points out, differs from the majority of trace elements in that it is a physiological constituent of plant and animal life. In plants it plays an important part in cell respiration; in the blood of vertebrate animals the formation of haemoglobin cannot take place unless traces of copper are present.

On the other hand copper is an active oxidation catalyst and if present in milk or butter to the extent of about two parts per million it activates some form of breakdown in the fat thereby imparting a tallowy flavour and impairing the keeping qualities of butter. Copper accelerates the destruction of ascorbic acid; copper salts in quite small quantities inhibit the action of pepsin and trypsin; and inorganic copper compounds are highly toxic to unicellular organisms such as algae.

It is not possible to state with any precision the amount of copper required daily by the human organism. Information available, however, suggests the amount required by an adult is from one to two mg., a quantity which would usually be supplied in a normal diet.

High Concentrations

At the other extreme when copper salts are present in sufficient concentration they are strongly astringent and irritating to the stomach. The medicinal dose of copper sulphate other than as an emetic is from 16 to 20 mg. Existence of chronic copper poisoning has not been established. From present knowledge it is not possible to assess the risk to health which may arise from the consumption of foods with an unusually high copper content. The presence of quite harmless amounts of copper can, however, render many foods and beverages unpalatable.

The main concern is to protect the consumer against the sale of foods with a copper content greatly in excess of the nutritional needs of the human organism. This hazard is not likely to arise unless food is processed under conditions conducive to copper contamination; verdigris could, for example, be a serious source of contamination.

Analytical data was received from the Government Chemist, the British Food Manufacturing Research Association, the Port Medical Officers of Health, the National Association of Cider Makers, the Institute of Brewing and food manufacturing firms.

Recommended Limits

Limits recommended by the sub-committee in its classification of foods and beverages include: wines, beer and cider 2 p.p.m.; edible gelatine (already prescribed) 30 p.p.m.; pectin, solid or liquid, 30 p.p.m.; tea, 150 p.p.m.; tomato ketchup (on the dried total solids), 50 p.p.m.; tomato purée (on the dried tomato solids), 100 p.p.m.; yeast and yeast extract, 30 p.p.m.

A provisional limit of 150 p.p.m. has been recommended for copper in tea in view of reports from the Tea Research Institute for Ceylon on the treatment of a disease known as blister blight, which is seriously affecting tea estates. Control measures involves the use of copper fungicides and at the experimental stage it is impossible to avoid a high degree of contamination. It may be possible to work to a lower limit when further experience of methods of control has been gained and the limit of 150 p.p.m. might be reviewed after one year.

In the meantime no exception need be taken to the importation of tea containing not more than 150 p.p.m. of copper. Only a fraction of the copper in the leaf is soluble and in view of the proportion which the weight of the infusion bears to the weight of the leaf the copper content of the infusion would not substantially exceed the limit of 2 p.p.m. recommended for beverages.

In view of the high natural copper content of certain animal and vegetable products, *e.g.*, shell fish and crustacea, offals, etc., specific limits for these articles have not been proposed, but it is recommended that the sale of such articles with copper over 20 p.p.m. should be permitted if it can be

shown that such copper is of natural occurrence.

It will be apparent that, from the public health standpoint, copper is in a different category from arsenic and lead and the subcommittee felt justified in recommending limits of copper content which ought not to present any problem for the food manufacturer. It is not suggested that these limits should be embodied in a Statutory Order immediately. There is room for further inquiry into the physiological function served by copper. The spoilage of food by copper contamination also calls for further research.

Finally, analytcal tests for copper in foods have hitherto only been undertaken by a few food manufacturing concerns and there is need for more comprehensive data. For these reasons it is considered that while there may be occasion, as in the case of edible gelatine and tomato ketchup, to prescribe limits for a few foods which are particularly liable to copper contamination the question of imposing comprehensive statutory limits might be reviewed in a year's time in the light of experience.

Members of the Metallic Contamination Sub-Committee were Mr. G. G. Barnes (chairman), Professor G. R. Cameron, Dr. L. E. Campbell, Professor S. J. Cowell, Dr. J. M. Johnston, Dr. W. P. Kennedy, Dr. G. W. Monier-Williams, Dr. J. R. Nicholls, Dr. G. Roche-Lynch, Mr. G. Taylor and Mr. B. W. Smith (secretary).

Mellon Institute Research

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The entire programme has been another excellent example of the value of the earnest and consistent support of research.

The piperonyl insecticides are increasing in both kinds and uses. Piperonyl cyclonene combined with pyrethrins and rotenone, with both of which it is synergistic, forms 'CPR' dust, which is being applied against insects harmful to truck crops. Piperonyl butoxide in combination with pyrethrins is marketed in 'Pyrenone' concentrates (U.S. Industrial Chemicals, Inc., New York). 'Pyrenone' is employed in liquid insecticide and aerosol formulations, described in the 'U.S.I. Insecticide Manual'. The addition of other insecticides is unnecessary. Safety to warmblooded animals has been proved for these piperonyl insecticides.

New control of insects destructive to grains has been announced recently by U.S.I. 'Pyrenone Wheat Protectant' and 'Pyrenone Grain Protectant' have been found to effect great savings in stored grains. 'Pyrenone Wheat Protectant' is a finely ground wheat treated with 'Pyrenone'. A 100 lb. of the protectant is mixed with 1,000 bushels of wheat, and protection for 10 months is claimed.

'Pyrenone Grain Protectant', for grains other than wheat, has a carrier of fibrous talc impregnated with 'Pyrenone'. In some areas insects have destroyed stored grains before spring and cattle have had to be sold before reaching the best marketable condition. 'Pyrenone Grain Protectant' safeguards the corn and makes possible a livestock industry in those areas.

Analytical Chemistry Congress

FURTHER details are now available concerning the arrangements for the International Congress on Analytical Chemistry which is to be held in this country next year.

The congress will meet at Oxford during the period 4-9 September, 1952, and the scientific sessions will be held in the rooms of the Examinations Schools.

Three main Congress Lectures by eminent chemists have been arranged. The programme for the scientific sessions is in the hands of a programme committee, under the chairmanship of Dr. G. M. Bennett, C.B.E., F.R.S., the Government Chemist, with Mr. L. W. Codd, M.A., of I.C.I., Ltd., as honorary secretary. This committee has appointed a number of advisers who are expert in their particular fields, and the draft programme has been divided on a basis of broad techniques.

Papers will be issued in pre-print form before the meeting and the contributors will give only a brief summary of their papers, most of the time being given over to discussion. Arrangements have been made to publish the whole of the proceedings in a special number, or numbers, of the *Analyst*, as soon as possible after the congress.

During the meeting it is proposed to have in operation working demonstrations illustrating new techniques or special applications of older techniques in analysis.

In addition to this and quite separate from it, there will be a trade exhibition comprising apparatus and books. This exhibition will be under the management of Mr. W. Thompson, of Imperial College.

Trace Metals in Biology

Polarographic Methods of Analysis—Part I

IN spite of a large volume of literature which has been devoted to the detection and estimation of trace metals in biological materials, that involving the polarographic method is relatively small. At first sight this appears a little surprising, especially as this type of application was among the earliest uses of the instrument.[1]

Unfortunately the analytical procedures which preceded the actual polarographic measurements were often suspect in the earlier publications. Thus procedures which involved removal of an unwanted constituent by precipitation, for example, iron as hydroxide, led to losses by adsorption of the metal ion on the precipitate. Such losses are very serious when only microgram quantities are present in the first case. This may have led to the use of other methods, chiefly colorimetric ones.

More recently, however, the polarograph has been used for determining trace metals in a variety of materials including foodstuffs. The latter appears to be a field of application which has been explored little, but one in which the method has great possibilities. Thus lead, the content of which must frequently be determined, can be estimated by a procedure which involves relatively little chemical manipulation and is rapid and reliable. It is discussed in detail below.

Merits and Limitations

The analyst is largely concerned with method, and while naturally interested in accuracy of determination, is obliged to consider whether such accuracy is counterbalanced by lengthy pre-treatment or manipulation. In this article an attempt is made to describe the various methods which have been used to determine a metal or metals, to consider their merits and limitations and to consider generally the scope of the polarographic method.

In normal biological materials the range of occurrence of trace elements is usually between the broad limits of 0.1 to 10 parts per million. Below this the analytical difficulties become severe, unless a large sample is readily available. This in turn frequently involves considerable pre-treatment and, if wet ashing is involved, appreciable amounts of reagents. In practice, therefore, 5 grams is a usual figure for the amount of starting material, corresponding to 0.5 to 50 micrograms of the trace metal.

Metals do occur, of course, in quantities higher than the above, as in contaminated foodstuffs or in tissues of animals which have had the metal incorporated in their food. It is, however, under the more severe conditions given above that the methods are considered, since only in this way can a distinction be made between a normal and an abnormal metal content.

There are, in general, three methods, and these may be classified as:

(1) Removal of the desired constituent.
(2) Indirect determination.
(3) Direct determination.

Difficulties of Ashing

Such determinations are usually preceded by either wet ashing with H_2SO_4 + HNO_3, often with the admixture of $HClO_4$, which is essential for arsenic and antimony; or dry ashing at 500°C. (less for lead, zinc, etc.). Although the latter is more rapid it is not unaccompanied by difficulties. Copper, for example, tends to combine with silica at elevated temperatures so that a platinum crucible should be used. On the other hand, if phosphates are present then the platinum may be corroded, so that wet ashing may after all be essential. Assuming that dry ashing is possible, this is carried out at the lowest temperature consistent with time of treatment and the complete removal of organic matter.

Removal of Desired Constituent

(*a*) *Removal as Vapour.* This has been applied to arsenic by two methods. In the first method[2] the material is wet ashed, and the arsenic liberated as AsH_3 by reduction with Zn. The vapour is then absorbed in $HgCl_2$ solution and the complex formed is decomposed by warming and addition of NH_2OH. Then NH_4OH is added until the solution is just alkaline. The mercury salts are completely precipitated and the arsenic is left as arsenite. On centrifuging and acidifying the solution with HCl, a wave is produced at the dropping mercury cathode

with a half-wave potential which varies according to the acid concentration ($E_{\frac{1}{2}}$ = −0.35 v. in 1.5N HCl, −0.50 v. in 0.5N HCl).

This method has been applied to various animal tissues and an accuracy of 5-10 per cent on 1-10 micrograms and 3-5 per cent on 10-100 micrograms is claimed. It is reputed to be as accurate as the Gutzeit test and more expeditious than the Molybdenum Blue test.

Arsenic Distilled as $AsCl_3$

More recently a Russian paper has appeared[3] in which the material is wet ashed and the arsenic is distilled over as $AsCl_3$ with HCl. After neutralising the distillate with Na_2CO_3 the solution is adjusted to approximately 0.5M of indifferent electrolyte, 0.015M of weak acid of simple mono- or dibasic fatty acid type, and 0.00015M of Co+++, Ni+++, or Fe+++. Usually ferrous ammonium sulphate is used for the latter. Such a solution without the arsenic gives a maximum between −1.2 and −1.5 volts (vs. S.C.E.). The addition of arsenic increases the height of this maximum and within limits the height increase is proportional to the added arsenic.

Solutions quoted for the determination of 0.01 to 0.05 mgm. moles per litre of As_2O_3 are:—

(1) 0.5M NaCl, 0.015M CH_3COOH, and 0.00015M $FeSO_4 . (NH_4)_2SO_4 . 6H_2O$.

(2) 0.4M Na_2SO_4, 0.35M NaCl, 0.015M CH_3COOH and 0.00015M $FeSO_4 . (NH_4)_2SO_4 . 6H_2O$.

The method has been applied to the determination of arsenic in flour, paper and bread and agrees to within 5 per cent with other methods.

(*b*) *Removal by Extraction.* Originally this method was suggested by Levy and Williams[4] for the determination of zinc in plant materials, using dithizone in $CHCl_3$ as the extracting agent. The method involves the standard procedure for the extraction of the metal from alkaline solution, stripping the zinc from this with dilute HCl and finally adjusting the *p*H to 4.6 with CH_3COONH_4. Addition of KCNS to 0.025N then gives well defined steps for Zn, Ni and Co. Unfortunately no results are given for the practical application of the method.

More recently a modified procedure[5] has been applied to the determination of zinc in biological material, such as blood, urine, fæces and animal tissues, also food, using the homologue of dithizone, di-β-naphthylthiocarbazone in $CHCl_3$ as the extracting agent. After partial destruction with HNO_3, the material is dry ashed at 500°C. and the residue taken up in 0.2N HCl.

Ammonium citrate and NH_4OH are added to *p*H 9.5 and then sodium diethyl dithiocarbamate. The zinc is then removed from the $CHCl_3$ layer by 0.2N HCl and is free from Cu, Ni, Co, Fe, Hg, Ag, Al, phosphate and sulphate. The solution is adjusted with NH_4OH until it is just acid to methyl red and polarographed between −0.8 and −1.3 volts ($E_{\frac{1}{2}}$ of zinc is −1.1 volts). It is suitable for amounts of zinc from 5 micrograms to 1 milligram and the results compare well with those obtained colorimetrically.

Cadmium in tissues has also been determined similarly by extraction with di-β-naphthylthiocarbazone.[6] The tissue is wet ashed and heated until fumes of SO_3 are evolved. After dilution, ammonium citrate is added and NH_4OH added until the *p*H is 8.3. Extraction is then done with the carbazone in $CHCl_3$. The cadmium is then removed by 0.2N HCl and evaporated to dryness.

The residue is then taken up in 0.1N HCl and KCl added, and, after degassing, the solution is polarographed from −0.5 to −0.9 (Cd has $E_{\frac{1}{2}}$ of −0.7 v. vs. S.C.E.). In this way amounts of cadmium from 2 to 500 micrograms can be determined with an accuracy of 2 to 10 per cent. The results compare favourably with those obtained by colorimetric and spectrographic methods.

Minor Constituent Removed

The extraction method has an advantage in that it provides a fairly complete separation of a minor constituent from considerable excess of other metals. Iron, for example, frequently occurs and interferes with the estimation of other metals. If present in the ferric condition it produces a wave on the polarogram even at zero potential. In the ferrous condition it is capable of producing waves in several other media. Its prior removal is, therefore, highly desirable.

This is simply accomplished by the addition of ammonium citrate prior to extraction when the iron is de-ionised. However, such extractions require a certain amount of manipulation, careful purification of reagents and they are time-consuming.

(*c*) *Removal by Electrodeposition.* A number of techniques are available for the

determination of micro amounts of metals by electrodeposition using controlled potential, and the subject has recently been reviewed by Lindsey.[7] In addition, a number of useful and simple procedures have been applied by Kovalenko[8] for the determination of trace metals in alloys. Removal by deposition has, however, been applied to the determination of lead in biological tissues. After dry ashing at 500°C. the residue is taken up in dilute HNO_3 and citric acid added and the *p*H adjusted to 1.5. The lead is deposited on a micro-cathode and the deposit is stripped into a solution of 0.8N HNO_3 containing 10 per cent tartaric acid.

The solution after degassing then gives a wave over the range −0.3 to −0.9 when polarographed ($E_{\frac{1}{2}}$ = −0.62 v. vs. S.C.E.). The method is suitable for amounts of lead down to 1 microgram and the results compare well with similar determinations carried out colorimetrically and spectrographically.

Electrodeposition is undoubtedly a very effective method for removing a constituent. The errors in direct weighing of the deposit are oxidation and adsorption, and this has largely militated against its application. However, when combined with the polarographic method, as indicated, it provides a powerful method of approach. This has been effectively realised by Kovalenko (see above).

(*d*) *Removal by Co-precipitation.* The difficulty, already stated, which arises from adsorption of ions on a precipitate, is used to 'collect' the trace metal. In a paper by Godar and Alexander[9] for the determination of tin in foodstuffs and biological materials, aluminium is precipitated as hydroxide and takes down the tin with it. After wet ashing and diluting, aluminium chloride is added and the solution is made alkaline with NH_4OH. The tin is thus effectively removed from Fe, Cu, Bi, Cd, Hg, Sb, Ni, Co, and Zn.

Combined Step Obtained

The precipitate is then removed by centrifuging and is dissolved in dilute HCl and NH_4Cl added. On polarographing, the solution gives a wave at −0.5 v. (vs. Hg pool). Only lead interferes and then a combined Sn + Pb step is obtained.

If lead is present, then the procedure is modified by addition of ammonium citrate and NH_4OH, when a wave is given for lead alone. A correction can thus be made and the tin alone estimated. In this way the tin content of milk products, prunes and fruit juices, peas, beans and mixed vegetables have been determined. The lower limit of the method is 0.5 p.p.m. with an accuracy of 5 per cent below 10 p.p.m. It is an improvement over the iodometric method which requires 50 to 100 grams of original material, the use of H_2S, and is time-consuming and messy.

Lead in Urine

The co-precipitation method has recently been applied by Baker[10] in biological studies for the determination of lead in urine. The urine is acidified with HNO_3 to a *p*H of 1.2 and then adjusted to a *p*H 4.4-4.6 by addition of NH_4OH. H_3PO_4 and $CaCl_2$ are then added and the precipitate of $Ca_3(PO_4)_2$ is thrown down, carrying with it the lead, free from iron and other metals. The precipitate is then dissolved in ammonium citrate and the *p*H adjusted to 5.2. On polarographing between −0.3 to 0.6 a wave is obtained for lead ($E_{\frac{1}{2}}$ = −0.49 v.). Alternately the calcium can be precipitated with the lead as oxalate at *p*H 4.5. This is then removed and decomposed with HClO and the phosphates re-precipitated as above.

These methods are claimed to be accurate to +25 micrograms per litre on a 20 ml. sample or +3 micrograms on a 100 ml. sample, *i.e.*, suitable for 0.5 p.p.m. on 20 ml. or 0.1 p.p.m. on 100 ml. samples. The method is used to study the increased excretion of lead after injection of B.A.L. (2, 3-dimercapto-propanol).

(*e*) *Removal by Ion-Exchange Resin.*—A good deal of research has been devoted to these resins, but little has been devoted to their use for estimating trace metals.[11] The method has, however, been applied by Cranston and Thompson[12] for the determination of copper in milk. The copper is associated with the proteins present and can easily be converted to the ionic form.[13] Treatment of the milk or reconstituted milk product with dilute HClO, at *p*H less than 3.0, precipitates the fat and the protein and leaves all the copper in the aqueous layer. After filtration the solution is adjusted to *p*H 5.0 with NH_4OH, and the liquid is passed through a column of the cation-exchange resin—Amberlite I.R. 100. This retains the copper quantitatively and it is

continued on page 238

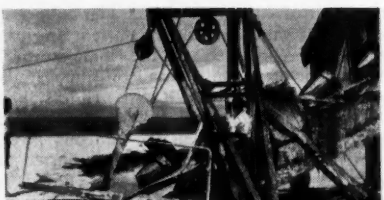
Magadi Soda Lake

An I.C.I. Outpost

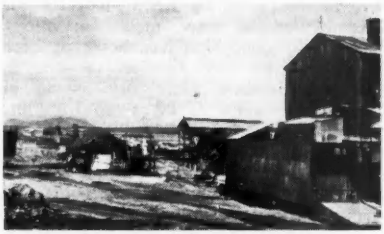
SODA recovery from Lake Magadi, Kenya Colony, was first seriously considered in 1911 with the flotation of a company called the Magadi Soda Company. Construction of a factory was begun at once and the works was almost ready to start when the 1914-18 war interrupted matters and this combined with technical problems of recovery resulted in financial difficulties.

In 1924 Brunner Mond & Co. sponsored a reconstruction scheme and a year later reconstituted the company under its own direction and control. In 1926, with the merger, the Magadi Soda Co. became an associate of Imperial Chemical Industries, Ltd.

Lake Magadi is about 2,000 ft. above sea level and is about 17 miles in length, with an average breadth of about 1½ miles. The soda deposit is in the form of sesquicarbonate of soda ($Na_2CO_3.NaHCO_3.2H_2O$), or trona, and is fairly evenly distributed.

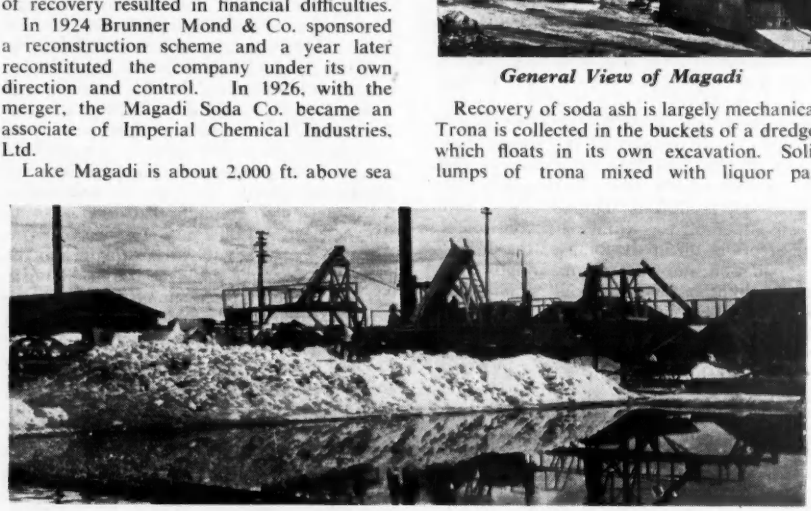


Dredge buckets digging up trona



General View of Magadi

Recovery of soda ash is largely mechanical. Trona is collected in the buckets of a dredger which floats in its own excavation. Solid lumps of trona mixed with liquor pass through breaking and crushing gear on the dredger pontoon, which reduces them to a size small enough to be pumped as slurry through a floating pipe line to the factory.



A view of the salt plant

After the slurry has been sieved and washed to remove impurities, the resulting crystalline mass is stacked in dumps and allowed to drain. It is then conveyed to calciners (long rotating kilns) which convert it into normal sodium carbonate—soda ash. Annual production of soda ash is over 100,000 tons.

Another product at Magadi is salt. The lake liquor is first subjected to solar evaporation, when the crude salt separates out on the surface of the ponds. This is harvested, dissolved, purified and recrystallised.

The Chemist's Bookshelf

ORGANIC CHEMISTRY. By I. L. Finar. Longmans Green & Co., Ltd., London, New York, Toronto. 1951. Pp. 696. 40s.

The present volume is an excellent textbook of organic chemistry in so far as it supplies the basic principles. It does not, however, outline a sufficient number of the branches of organic chemistry for the student to pick his subject for specialisation or become acquainted with fields other than his own. The writer displays great learning and considerable experience of teaching, and the book has a most businesslike beginning. Thus, a single page covers the history of organic chemistry, and three more pages summarise methods of analysis, which is as it should be for this very specialised subject.

Although a student could learn organic chemistry required for examinations from this book, it is advantageous that he should already be familiar with it from a Primer. The subject is so vast that he must have a framework where the details can be filled in. A considerable proportion of the book is devoted to the various general reactions which are the essential tools of the organic chemist and many of which are recent discoveries. The theoretical side of organic chemistry is treated with great lucidity and thoroughness. Thus the comparison between aldehydes and ketones could act as a classical model for the literary treatment of related substances and greatly facilitates the memorising of this by no means easy subject.

The same care is given to other fundamental substances. Tautomerism is the subject of a fine chapter and is not only instructive but makes also good reading.

Regarding the shortcomings of the book, it is difficult to assess how much of these are due to the author and how much to the present trend to cut down expenses and hope for the best. Apart from dyestuffs and sugars, branches of organic chemistry have not been accorded the importance which they possess in industry and in life. Bakelite which forms a most important industry is barely mentioned, tannins are only referred to as the parent bodies of gallic acid. There is nothing about synthetic tannins which are now indispensable in the leather trade. Glyptals deserve much more than the word 'plastics (glyptals)'.

More should have been written about 'Nylon' even if only to relieve the tedium of complicated matter. The same applies to methyl methylacrylate, the parent body of 'Perspex', and styrene. Proteins are not discussed at all. The word alkaloids does not occur even in the index, nor is anything said about quinine, morphine and cocaine. Menthol is not even mentioned, and of camphor the formula only is given and its use as a component of celluloid. The essential amino-acids are only indicated very sketchily, and separate chapters should have been devoted to rubber, natural and synthetic, proteins, alkaloids, terpenes and related substances.

These omissions greatly detract from the general excellence of the book. It means that a student will have to refer to other smaller books in order to qualify for some of the examinations for which this book is intended. An amplification of these matters may mean the addition of 50 more pages and would not only facilitate the work of the student but considerably increase its value to the general reader. The publishers could also have done much by setting out the headings in separate lines (not just inset) in several kinds of large type and spacing them generously. Great discoveries as that of free radicals certainly deserve a separate heading and a reference in the index. The index, too, could do with extension. Rubber, for instance, does not occur in it, and although phthalocyanines have a small chapter of their own, the word does not appear in it either. Such additions would have made the student independent of other books and would have speeded up a second edition which this book certainly deserves.—S.P.S.

D

PHYSICAL METHODS IN CHEMICAL ANALYSIS. Vol. II. Edited by Walter G. Berl. 1951. New York: Academic Press Inc. Pp. xii + 640. $13.50.

This volume completes the series of advanced monographs on selected methods of instrumental analysis written by recognised experts, which was initiated by Volume I (CHEMICAL AGE, 1950, *63*, 233). The very high standard, both of matter and presentation, is fully maintained here.

Where Volume I was primarily concerned with methods involving 'light' of various wavelengths, the present volume deals mainly with electrical and magnetic methods which have been or are likely to be of value in chemical analysis. Here, also, are included techniques which cannot properly be classified in either category. There is in addition a section on the statistical analysis of experimental data.

The review of the first volume made it clear that these monographs are exceedingly valuable both from the theoretical and the experimental aspects to all those who use or depend on analytical techniques. Those who have acquired Volume I cannot fail to be desirous of completing the reference work by adding this second volume. It only remains for this review to give an indication of the contents, which can best be done simply by listing the titles of the sections. The names of the authors are a guarantee of the authoritative nature of the contents. The sections are as follows: Metallurgical Polarographic Analysis and Polarimetric Titrations, by J. Heyrovsky. Conductometric Analysis, by H. T. S. Britton. Potentiometric Analysis, by H. A. Laitinen. Electrography and Electro-Spot Testing, by H. W. Hermance and H. V. Wadlow. Magnetic Methods of Analysis, by A. R. Kaufmann. The Determination of the Area of the Surfaces of Solids, by G. Jura. Surface Tension Measurements, by M. Dole. Vacuum Techniques and Analysis, by B. B. Dayton. Gas Analysis by Methods Depending on Thermal Conductivity, by E. R. Weaver. The Measurement of Radioactivity for Tracer Applications, by A. Langer. Statistical Analysis, by J. Sherman. Chromatographic Analysis, by W. G. Berl.

It is, perhaps, curious that electrography has been considered as being suitable for inclusion, while there is no section devoted to gravimetric electrodeposition techniques. These are equally dependent on apparatus and on physico-chemical principles.

It is not possible in the space available to discuss in detail the individual monographs, since each would, in effect, merit a full-length review. And to pick out one or two for special consideration would be an invidious procedure for which there is no warrant. However, it would not be proper to close this review without saying that analytical chemists owe a considerable debt to the editor, authors and publishers for these two exceedingly valuable volumes. It is depressing but inevitable that the present volume, which compares closely in size with Volume I, and appears less than a year later, is dearer by twelve and a half per cent. —C.L.W.

METAL STATISTICS, 1951. By N. J. Langer. American Metal Market, New York. Pp. 808. $2.00.

The 44th annual edition of 'Metal Statistics' contains the same general assortment of statistical information on ferrous and non-ferrous metals, and miscellaneous economic subjects and on sources of supply, as was supplied in previous issues. Reliable data from the U.S.S.R. and satellite nations continues to be lacking, so world statistics on production and consumption remain unsatisfactory so far as totals are concerned. Consequently, wherever such totals are shown, they must be regarded as largely conjectural.

Additional information on domestic copper consumption is furnished for this edition by the Bureau of Mines, and statistics dealing with production are gathered from various authentic sources. They cover a wide range of interest, supplying a complete record in every instance on production, consumption, average prices, trade terms, specifications, grades, brands, analyses, customs duties, etc., applying not only to the raw material but also to the semi-finished and finished products. Ten pages of contents index give a fairly good idea of the amount of statistics presented and a Buyers' Directory Section covers 136 pages.

Trade and industry realise nowadays the importance of studying price and production trends and on the title page of the book therefore justly appears the quotation by Patrick Henry: 'I know no way of judging the future but by the past'.—F.N.

Publications & Announcements

IODINE as a catalyst is the subject of the two latest reviews (Nos. 31 and 32) in its series 'Iodine Information' issued by the Chilean Iodine Educational Bureau. The first gives a useful résumé of the general nature of catalytic reactions, the second summarises the uses of iodine and its compounds as catalytic agents in many types of industrial chemical processes. Principal examples given are halogenation, condensation, alkylation, hydrogenation, sulphuration and sulphonation, and general organic synthetic operations. A bibliography of the more important papers on the subject is given and also a list of patents included in the references. The publications may be obtained free of charge on application to the bureau.

* * *

PROGRESS at Wilton is reviewed by Dr. J. W. Armit, chairman of the Wilton Council, in an illustrated article in the August issue of the 'I.C.I. Magazine' (Vol. 29, No. 178). The first stage of Wilton consists of 10 manufacturing plants belonging to five of the company's Divisions with all the main and subsidiary services they require. Already there are in operation plants and services to a value of £15 million. By 1953 the first ten years of the project will have been completed and two further polythene units about to be sanctioned should then be coming into operation. Developments in the second stage include a 5,000-ton 'Terylene' plant and a 15,000-ton phthalic anhydride plant.

* * *

ORGANIC reagents for copper and zinc—sodium diethyldithiocarbamate and diethyl ammonium diethyldithiocarbamate—are the subject of Monograph No. 1 (1951), just issued by Hopkin & Williams, Ltd. The monograph has been compiled and published in response to requests for up-to-date information on organic reagents for metals. Similar monographs were previously published in a collective volume 'Organic Reagents for Metals and Certain Radicals', the fourth and latest edition of which appeared in 1943. Owing to rapid developments in the uses of organic analytical reagents the task of compiling a critical and up-to-date collective volume has had to be postponed, but individual monographs will be issued from time to time, free of charge.

ALKATHENE stoppers for measuring cylinders and flasks incorporating many special features have just been announced by H. J. Elliott, Ltd. The new E-Mil stopper, approved by the NPL is highly unreactive to a wide range of analytical reagents and organic solvents. Due to the perfect contact between the glass neck and the plastic shank of the stopper loss is prevented of solutions due to leakage or 'creep' which is often experienced with the most accurately ground dry glass surfaces unless a lubricant is used. Self-locking, the stopper is light in weight, interchangeable and 'freeze' proof. The umbrella shape of the protective head gives considerable freedom from dust on the neck flanges, and if the vessel is knocked over the head takes the main force of the blow thereby reducing breakages. The stopper is being patented in Canada, and the U.S.A.

* * *

MUCH research work on corrosion prevention has been carried out by the Dunlop Rubber Co., Ltd., and a booklet on its anti-corrosion service has recently been issued by the company. Examples : the lining of chemical plant, pipes, tanks and so on with soft rubber, ebonite, butyl, PVC and neoprene are described and illustrated.

* * *

POTASSIUM DICHROMATE production in Australia and the corrosion problems involved are described and illustrated in 'Wiggin Nickel Alloys', No. 15, published by Henry Wiggin & Co., Ltd., Birmingham. The plant installed by Chrome Chemicals, Pty., Ltd., Parramatta, N.S.W., was fabricated entirely from Monel after severe tests, and includes: a reaction evaporator, 13 ft. in diameter and 8 ft. 2 in. in height; two granulating tanks; a mother liquor tank; storage tank; and heating and cooling coils.

HOME

Chemicals in Food

Problems arising from the use of chemicals in food will be discussed at a conference being organised by the Food, Agricultural and Fine Chemicals Groups of the Society of Chemical Industry. The meeting will be held on Thursday and Friday, 27 and 28 September at the Wellcome Research Institution, Euston Road, London, N.W.1.

Scottish Industrial Plant

Continued expansion of the high-vacuum industry is reported from Wishaw where British-American Research is now located. The company is building industrial plant of a type not formerly available in Scotland making it possible to apply on a commercial basis work only handled in the laboratories. Uses of Scottish-made plant include commercial production of streptomycin, penicillin and blood plasma.

Factory Starts on Time

Production began on schedule on 7 August at the new Bowesfield Construction Works of the Power-Gas Corporation, Ltd., Stockton. The new factory has a floor area of over 130,000 sq. ft., and has been built in just under a year. Beside valuable export orders, the firm and its associated company, Ashmore, Benson, Pease & Co., Ltd., have orders for mobile ladles for the new Steel Company of Wales, a gasholder for Coventry and gas producers for the British gas undertaking.

Chemical Engineering in Scotland

Demand for chemical and distilling plant continues to give satisfactory employment in Glasgow according to D. M. Semple, chairman and managing director of the Mirrlees Watson Co., Ltd. In its Scotland Street plant the firm has two triple effect vacuum salt evaporators under progress and two 'Vellez' filters in which all parts in contact with the process liquor are in stainless steel. Two tannin extract units are also under construction, consisting of leaching batteries, evaporating retorts, rectifiers and condensers. A gin still, a glucose convertor and a film evaporator for urea are among the other items in progress at Govan. Condensing, pumping and centrifugal equipment is also in satisfactory demand.

Prices of Oils and Fats

The Minister of Food announces that no change will be made in the prices of unrefined oils and fats and technical animal fats allocated to primary wholesalers and large trade users during the four week period ending 8 September, 1951.

Ministry of Materials

The Press office of the Ministry of Materials, Horse Guard Avenue, Whitehall, S.W.1 (Telephone: TRAfalgar 8888, ext. 7610) opened on Tuesday, 7 August. Mr. Richard Miles, formerly with the Information Division of the Treasury, has been appointed Press officer.

Welding Research

Annual General Meeting

THE 6th annual general meeting of the British Welding Research Association was held at the Research Station, Abington, near Cambridge, on 25 July.

Sir Charles Lillicrap as chairman of the council introduced the report of the association for the year. He was pleased to report a very satisfactory year's work by the various research committees and a continued increase in membership. It was becoming increasingly evident that those in industry interested in welding were taking full advantage of the resources of the BWRA.

Recently a Summer School had been organised at Ashorne Hill and so successful was this venture that tentative plans were being made for a similar course to be held next year. The liaison staff backed by the investigators had been receiving more calls than heretofore for advice from members and non-members, and translating highly technical data into workshop practice. This important task of bridging the gap between the research laboratory and workshop served a basic object of the association.

On the financial side, the council, bearing in mind the capital commitments involved in purchasing plant and building a laboratory, had transferred to reserves the sum of £2,400. The council considered it imperative for the association to have adequate facilities for effective research.

• OVERSEAS •

Chilean Mercury

Geologists of the U.S. Department of the Interior in co-operation with Chilean scientists have just completed a survey of the country's quicksilver deposits. This is part of a co-operative programme in being between the two countries and was made at Chile's request.

World Power Conference

At a meeting of the International Executive Council of the World Power Conference, held at Paris last month, it was decided to accept an invitation from the Brazilian National Committee which, with the support of the Brazilian Government, has issued an invitation for a Sectional Meeting of the World Power Conference to be held at Rio de Janeiro in the period July-August, 1954. Topics to be discussed will centre round the special power and fuel problems of the tropical and sub-tropical countries. The German Federal Republic and Japan have been admitted as members of the Conference. The 1950 annual report is now obtainable (1s. 6d. post paid).

Sulphur from Indian Coal

Experiments carried out by the Indian Fuel Research Institute on the washability of coal in the Rew District of Uttar Pradesh have indicated the presence there of an abundance of sulphur. Tests carried out have established the possibility of obtaining 40 tons of sulphur from this source as a by-product. At present, India's total requirements of sulphur are 65,000 tons per annum and almost the whole is shipped from the U.S.A., and Italy.

Yugoslav Caustic Soda

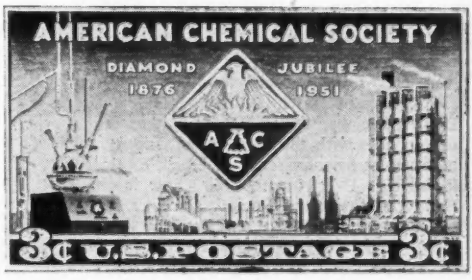
In Yugoslavia to-day three plants are producing caustic soda—one by the Solvay method and two by the electrolytic method. Their exports are now pooled and effected through a central agency, the Hempro Chemical Trading Corporation, Belgrade.

Austria to Increase Iron Ore Output

The first ECA authorisation of $435,000 for the purchase of mining equipment in the United States was granted to Austria in July, with a view to increasing iron ore output from the Erzberg in Styria in the British zone. This allocation forms part of a scheme to increase the Erzberg's monthly output from the present level of 5,600 tons to 7,400 tons, at a total cost of $2,326,000, 27 per cent of which is to be financed by direct ECA aid.

South African Surplus

Owing to world scarcity of sulphur, a switch-over from a sulphur- to a pyrites-burning plant, costing upwards of £500,000, is planned for the Umbogintwin factory of African Explosives and Chemical Industries, Ltd. All the Union's sulphur is at present imported from the American Gulf Coast, making a total in 1950 of 90,000 tons. This year about 60,000 tons is expected to be the allocation. The South African sugar industry has been guaranteed the 7,000 tons of sulphur which it needs this year, but next year's supplies are doubtful. The conversion is expected to take two years and will make the Umbogintwin factory independent of sulphur. Another investigation is being carried out on the pyrites in gold ore.



The stamp which will be issued on 4 September to commemorate the 75th anniversary of the American Chemical Society. In the centre is the emblem of the society. On the left is a modern alembic with instruments, hydrometer and ionisation indicator. Below and to the right a '20th century horizon,' with the towers of a catalytic cracking plant, a butadiene reactor and a fractionating unit.'

[By courtesy of 'Stamp Collecting.']

PERSONAL

Professor A. V. Hill

PROFESSOR A. V. HILL, C.H., O.B.E., F.R.S., was elected next year's president of the British Association for the Advancement of Science at its annual general meeting in Edinburgh last week. The professor was educated at Blundell's School, Tiverton, and Trinity College, Cambridge. He is noted for his work on biophysical subjects and received the Nobel Prize for Physiology and Medicine in 1922. Among the important positions he has held are: Secretary of the Royal Society 1935-45, Foreign Secretary 1945-46; chairman executive committee, National Physical Laboratory 1939-45; member of the War Cabinet Scientific Advisory Committee, 1940-46; Advisory Council, DSIR, 1940-46; Scientific Adviser, Government of India, 1943-44. The professor is also on the General Advisory Council of the BBC, a Trustee of the British Museum, and chairman of the Society for the Protection of Science and Learning. His awards include the Medal of Freedom, with Silver Palm, U.S.A., 1947; the Copley Medal, 1948; and Chevalier of the Legion of Honour, 1950.

At the recent annual general meeting of the British National Committee of the World Power Conference DR. A. PARKER, C.B.E., director of Fuel Research, DSIR, was elected to fill the vacant post of honorary secretary. Other officers of the committee are: *Chairman*: SIR VINCENT DE FERRANTI; *vice-chairman*: MR. HAROLD HOBSON; *honorary treasurer*: COLONEL C. M. CROFT.

The following staff appointments are announced by Evans Medical Supplies, Ltd.: MR. K C. AYLETT, Ph.C., F.C.S., to the staff of Productos Evans, S.A., in Brazil; MR. R. A. CRAWFORD, Ph.C., A.R.I.C., D.B.A., transferred from Speke to Evans Pharmaceutical Laboratories as a departmental manager; MR. R. C. WHITEHOUSE, M.P.S., transferred to the research department at Evans Pharmaceutical Laboratories; MR. A. HARRISON, B.Sc., Ph.C., and MR. W. McCLAY, M.P.S., have joined the staff of the Sterile Products Unit.

Obituary

The death in a London hospital, following an operation, was reported last week of PROFESSOR ARTHUR JOHN ALLMAND, M.C., F.R.S., Professor Emeritus of Chemistry at King's College, University of London. He was 66. Educated at the University of Liverpool, he later studied in Germany. During the war the professor was seconded for services with the Ministry of Supply and became superintendent at the Explosive Research Department. He had been a Fellow of the Royal Society since 1929, and was a past president of the Faraday Society. His original work lay mainly in the fields of electrochemistry and photochemistry.

Professor A. J. Allmand

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G 9

Trace Metals in Biology

continued from page 229

then removed from the column by passing dilute HCl.

The eluate is then made alkaline with NH_4OH and the solution polarographed. The characteristic double wave of copper is given. The limits for copper in the U.S. are more severe than in this country and a value of not more than 0.2 p.p.m. is stipulated. Consequently a method suitable for 0.1 p.p.m. is required. It was found that the above method was adequate, but it requires a rather larger sample than usual (250 ml. milk or 25 grams of powdered milk).

The results agree closely with those obtained by spectro-photometric estimations on the dithizone complex, and also those obtained by a wet ashing technique, though it is more rapid and convenient than the latter.

The use of ion-exchange resins has been recently studied by Riches[14] with a view to its general application to trace metals in plant materials. Working with only 20 micrograms of Cu, Cd, Ni, Zn, and Mn in 2N NH_4Cl, he has shown that it is possible to absorb and strip them from a column almost quantitatively with dilute HCl. Further, by using the metals in 0.1N ammonium phosphate, they can be freed from the phosphate radical, which is a valuable asset since it frequently occurs in tissues and is liable to cause precipitation in alkaline solution. Though as yet not generally applied, the method promises to be one of the simplest and most rapid aids to the isolation of trace metals.

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Board of Trade H.Q.

Transfer of Divisions

HEADQUARTERS of the Board of Trade is being transferred to Horse Guards Avenue, Whitehall, London, S.W.1. (Telephone: TRAfalgar 8855). Many of the branches of the Industries and Manufactures Department, Division 2, have already moved to the new offices; the principal officers of the Secretariat are expected to follow shortly. Further divisions of the Board will be transferred from Imperial Chemical House and Thames House (North) to the new offices in the autumn.

Until further notice, correspondence for Divisions of the Board of Trade hitherto housed in Imperial Chemical House and Thames House (North) should be addressed as follows:—

HORSE GUARDS AVENUE, WHITEHALL, LONDON, S.W.1. (Telephone: TRAfalgar 8855):

The President, Overseas and Parliamentary Secretaries, Secretariat and Information Division (from 13 August);

Industries and Manufacturers Division, Branches 2A and 2D;

Industries and Manufactures Division 2B (dealing with organic and inorganic chemicals and plastic materials).

I.C. HOUSE, MILLBANK, LONDON, S.W.1. (Telephone: WHItehall 5140):

Commercial Relations and Exports Department, Films Division.

THAMES HOUSE (NORTH), MILLBANK, LONDON, C.W.1 (Telephone: VICtoria 9040):

Commercial Relations and Exports Department (Industries Branch).

Industries and Manufactures Division Branch 2B and 2C (dealing with the production of rubber goods, paints, printing inks, synthetic resins, pesticides, insecticides, asbestos manufactures, bichromates, glue and cork manufactures, dyestuffs, alkalis, chlorine, certain sulphur and zinc derivatives, footwear, gloves and leather goods, furniture, pianos, basketware);

Industries and Manufactures Division, Branch 1;

Distribution of Industry and Regional Division;

Solicitor's Department;

Statistics Division.

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Commercial Intelligence

The following are taken from the printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described herein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages or Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

PETROCHEMICALS, LTD., London, W. (M., 18/8/51). 5 June, mortgage supplemental to a Trust Deed dated 17 May, 1949; charged on specified shares; also mortgage supplemental to a Trust Deed dated 30 December, 1949; charged on specified shares. *£4,300,000. 23 May, 1950.

New Registrations

T. O. Marshall, Ltd.

Private company. (498,214). Capital £3,000. Wholesale and retail consulting, analytical, manufacturing, pharmaceutical and general chemists, etc. Directors: O. Marshall and Miss L. Marshall. Reg. office: 33 High Street, Wallsend-on-Tyne, Northumberland.

A. H. McBryde, Ltd.

Private company. (498,250). Capital £2,000. Wholesale or retail consulting, analytical, manufacturing, pharmaceutical and general chemists, etc. Directors: P. Heyes, Mrs. G. O. Heyes and N. Rea. Reg. office: 295/7 Whitley Road, Whitley Bay.

Menovo, Ltd.

Private company. (498,234). Capital £100. Manufacturers of pharmaceutical, medicinal, chemical, industrial and other preparations. Directors: C. Cooper and S. W. Goody. Reg. office: 2 The Green, Richmond, Surrey.

W. P. Laboratories, Ltd.

Private company. (498,030). Capital £500. Manufacturers of plastic materials, chemicals, gases, etc. Directors: F. J. Weil and I. Preis. Solicitors: D. W. Plunkett, 230 Gt. Portland Street, W.1.

Zeal Chemical Mfg. Co., Ltd.

Private company. (498,074). Capital £7,500. Directors: V. Gregory and J. Hudson. Reg. office: 30 Coburg Street, Fratton, Portsmouth.

Aeromist, Ltd.

Private company. (497,980). Capital £3,000. Manufacturers of insecticides, chemicals, etc. Directors: J. A. Linfield and H. R. Barnes. Reg. office: 12 Upton Road, Watford, Herts.

Increases of Capital

The following increase of capital has been announced:—H. C. ATKINS LABORATORIES, LTD., from £3,000 to £25,000.

Company News

Johnson, Matthey & Co., Ltd.

Benefits of new techniques, the extensive research laboratories, the refineries and the works laboratories were referred to by Mr. Hay W. P. Matthey, chairman, in his report to the 60th annual general meeting of Johnson, Matthey & Co., Ltd., held recently in London. Among the wide range of heavy industrial products referred to was a continued demand for silver for chemical plant. One instance was the making of one single piece of silver for the eventual production of a tubular vessel, the initial casting weighing just over two tons. Platinum in various forms was also required for chemical plant. Net profit for the year ended 31 March, after providing for taxation, was £399,998. Final dividend of 12 per cent on ordinary shares was approved.

British Glues & Chemicals, Ltd.

New products including fertilisers and protective mineral supplements helped to increase production of British Glues and Chemicals, Ltd., during the year ended 30 April, 1951. Sir Roger Duncalfe, chairman, in his report to be presented at the annual general meeting on 13 September, pays a special tribute to the selection and training of younger personnel on whom the future of the company depends. Consolidated profit for the year was £422,434 (£253,344). Rising costs of building, plant and machinery made the original amount for replacement insufficient and £80,000 is to be appropriated to reserve for this purpose. A second interim dividend of 25 per sent. making 30 per cent for the year, is recommended. It is proposed to issue as a bonus £50,000 ordinary stock (two 4s. units for every nine units held).

Market Reports

LONDON.—The markets have not shown any outstanding feature during the past week, and with seasonal influences less in evidence, fully active conditions have returned to most sections. New contract business is receiving the attention of home trade buyers, and a considerable weight of orders for overseas destinations is reported. Prices generally continue strong. In the coal-tar products market the demand continues in excess of available supplies and there appears to be little prospect of any early improvement despite a higher output. A steady demand for pitch is reported for home account.

MANCHESTER.—Fair trading activity has been reported for heavy chemical products during the past week. In a number of sections buyers are experiencing difficulty in placing orders for near delivery dates. Holidays in industrial centres in Lancashire are affecting the movement of supplies to some extent, but in spite of this seasonal factor good quantities of caustic soda and other alkali products are being taken up by consumers. There is also a steady demand for a wide range of other products, including the barium compounds. Barium chloride is dearer by £2 a ton. Most of the tar products are active.

GLASGOW.—The past week has been uneventful with a steady demand upon all branches of the trade. With the start of the main English holiday season trade has inclined to be somewhat slacker.

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LONDON BRICK COMPANY invite applications to fill a post in its Technical and Research Department, located near Bedford. The applicant should be a University Graduate with experience in Industrial Geology or Ceramic Technology, or both. Salary according to qualifications and experience. House available for successful applicant. Apply to: **London Brick Company Limited, Africa House, Kingsway, London, W.C.2.**

OIL Refinery Contractors handling large contracts for refinery plant require **CONTRACTS ENGINEERS** in their London office. Duties involve broad direction and co-ordination of all phases of the work, including planning, drafting, purchasing, progressing and erection. Desirable qualification is previous experience, including a wide knowledge of pumping, heat exchange equipment and instrumentation, and the appointments offer excellent prospects to suitable men. Applicants should write fully, stating qualifications, age and experience to **Foster Wheeler, Ltd., 3 Ixworth Place, London, S.W.3.**

SENIOR ASSISTANTS (SCIENTIFIC). The Civil Service Commissioners invite applications for 30 permanent appointments in the following categories:
(a) **GLASSBLOWERS,** experienced in making equipment for general laboratory work.
(b) **CHEMISTS,** experienced in analytical work, for the testing and analysis of soils, feeding-stuffs, fertilisers, milk, etc.
(c) **BACTERIOLOGISTS,** experienced in laboratory routine.
(d) **BIOLOGISTS,** experienced in the routine of a general biological laboratory and having specialised in either Plant Pathology or Entomology and Microscopy.
(e) **BIOCHEMIST,** with knowledge of hygiene and pathology and ability to assist in teaching in these fields.
(f) **BIOCHEMIST,** with sound knowledge and experience in nutritional work.
(g) **CHEMICAL ENGINEER** for supervisory duties.
(h) **ELECTRONICS ENGINEER** with specialised knowledge of Post Office relays.
(j) **TECHNICIANS (MEN ONLY)** with experience of work in a physiology laboratory or **ENGINEERS** with simple knowledge of pneumatic or hydraulic engineering.
(k) **GENERAL ASSISTANTS** in Applied psychology.
Except as stated at (j) the competition is open to men and women.
Candidates must have been born on or before 1st August, 1924.
Candidates must produce evidence of having reached a prescribed standard of education in science and of thorough experience in the duties of the class.
Inclusive London salary scales (men) £475×£20—£625; (women) £405×£15—£515. Rather less in the provinces.
Further particulars and application forms from **Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S 4054/51 T.B.** Completed application forms must be returned by 13th September, 1951.
12539/100/FW

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AMBITIOUS CHEMIST and PHYSICIST, qualified in both subjects, experienced in Development and A.I.D. inspection of paints, protective coatings, pretreatments, emulsions, road building and thermal insulating materials, seeks permanent post where hard work, reliability, loyalty and initiative are appreciated. London area preferred. Please write to, Box No. C.A. 3034, THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4.

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ONE mild steel **AUTOCLAVE,** 6 ft. by 4 ft. of riveted construction from $\frac{7}{16}$ in. plate, with hinged lid arranged with swing bolts. In good condition.
ONE mild steel **AUTOCLAVE** as above, measuring 5 ft. by 3 ft. 3 in., from $\frac{3}{8}$ in. plate. In good condition.
THREE 100 gallon, mild steel **JACKETED BOILING PANS** mounted on three legs, bottom centre outlets, certified for 100 lb. working pressure.
TWO 450 gallon as above, certified for 50 lb. working pressure.
TWO 200 gallon as above, test certificates available.
ONE 50 gallon stainless steel **JACKETED BOILING PAN,** cast-iron jacket.
Any of the above pans can be arranged with mixing gear.
THREE 200 gallon, open top, stainless steel **TANKS,** two 20's gauge and one 12's gauge.
'MORWARD' TROUGH MIXERS, with scroll type agitators in 4 ft., 6 ft. and 8 ft. sizes: Electrically driven.
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Two **FILTER PRESSES**, chamber type, steam heated, centre fed with separate outlet taps.

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Four **ROTARY BOWL MIXERS**, 5 ft. diam., cast iron built, inclined agitators, by Baker Perkins.

One Broadbent under-driven **HYDRO EXTRACTOR** self-balancing type, with self-contained A.C motor.

Two **FILTER PRESSES**, fitted recessed C.I. plates, 40 in square, 2½ in. thick, centre fed, to make 11 cakes per Press.

Kek **GRINDING MILL**, square pin type, with grinding discs 13 in. diam., including circular delivery bin with single outlet.

Large unjacketed **WERNER MIXER**, belt and gear driven, hand tipping, double " Z " arms, pans 53 in by 45 in by 36 in. deep.

No. 200 One nearly new **WERNER PFLEIDERER JACKETED MIXER OR INCOPORATOR.** Low type, with C.I. built mixing chamber, 28 in. by 29 in. by 27 in. deep, with double " U "-shaped bottom which is jacketed, and double fish-tail or fin-type agitators geared together at one side, with belt-driven friction pulleys, 34 in. diam. by 5 in. face, with hand-wheel operation and hand-operated screw tilting gear. Machine fitted with machine-cut gears covers, gear guard, cast-iron baseplate, and measuring overall approximately 7 ft. by 6 ft. by 4 ft. high to the to of the tipping screw.

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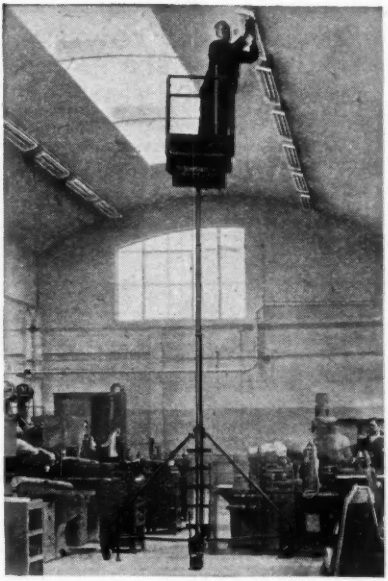

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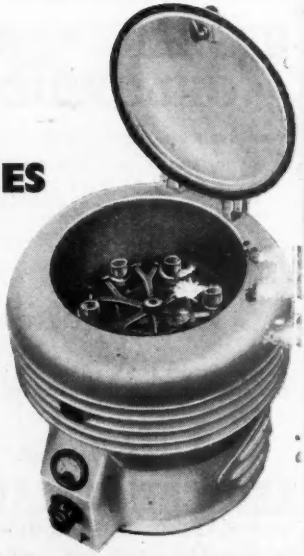

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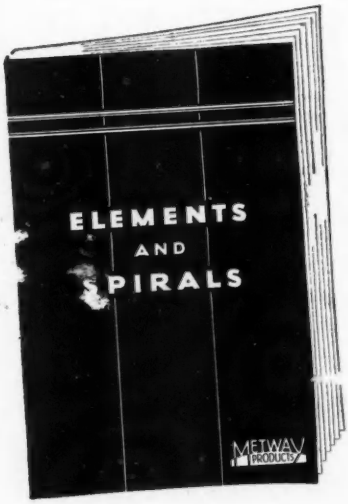

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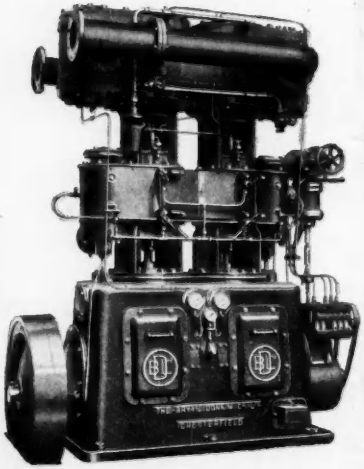

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